Section 6
Rehabilitation Strategy

WINCHESTER SOUTH PROJECT
Environmental Impact Statement

WHITEHAVEN COAL

Resource Strategies

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

6 REHABILITATION STRATEGY

This section describes the proposed approach to rehabilitation and decommissioning of the Project. It describes how the Project would be progressively rehabilitated and integrated with the adjoining natural landscape, and the measures that would be put in place for the long-term protection and management of the site following the cessation of mining.

6.1 REHABILITATION REQUIREMENTS

The following relevant legislative requirements, policies, guidelines and best practice approaches have been considered in developing the rehabilitation strategy for the Project:

- *Mined Land Rehabilitation Policy* (DEHP, DNRM and Queensland Treasury, 2017);
- relevant regional plans and local planning schemes;
- *Guideline – Progressive rehabilitation and closure plans (PRC plans)* (DES, 2019b);
- *Guideline – Application requirements for activities with impacts to land* (DES, 2019a);
- *Land – EIS Information Guideline* (DES, 2020f);
- *Contaminated Land – EIS Information Guideline* (DES, 2020i);
- *EIS Information Guideline – Rehabilitation* (DES, 2016d);
- *Integrated Mine Closure Good Practice Guide* (International Council on Mining and Metals, 2019);
- *Strategic Framework for Mine Closure* (Australian and New Zealand Minerals and Energy Council, Minerals Council of Australia, 2000); and
- *Leading Practice Sustainable Development Program for the Mining Industry: Mine Rehabilitation; Mine Closure* (Commonwealth of Australia, 2016a and 2016b).

6.1.1 Mined Land Rehabilitation Policy

The objective of the *Mined Land Rehabilitation Policy* is for land disturbed by mining activities to be rehabilitated to a safe and stable landform that does not cause environmental harm and is able to sustain an approved PMLU (post-mining land use).

The policy requires land disturbed by mining to be progressively rehabilitated as it becomes available, to minimise the risks of environmental impacts and reduce cumulative areas of disturbed land.

In accordance with the *Mined Land Rehabilitation Policy* (DEHP, DNRM and Queensland Treasury), portions of the Project would be progressively rehabilitated according to the Project schedule of works (Section 2.1.8) to achieve the objectives of the proposed low-intensity grazing PMLU (Section 6.6). Rehabilitation progress would be monitored against milestones and completion criteria to demonstrate successful rehabilitation of the Project (Section 6.6).

The final landform also includes some areas with no proposed PMLU. These areas however would be safe, stable and non-polluting (Section 6.3). Progressive development and rehabilitation of the Project is shown on Figures 6-1 to 6-5.

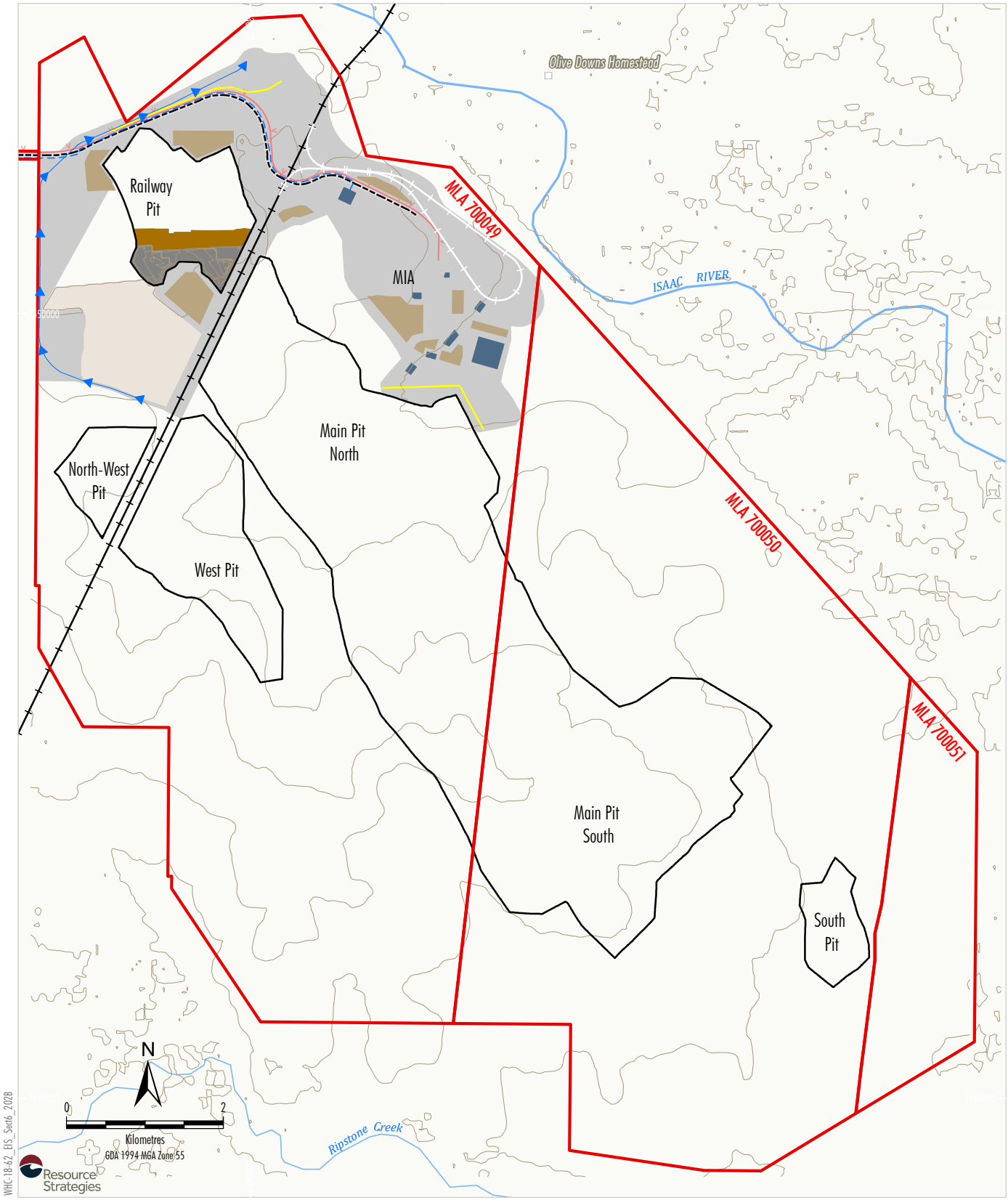
6.1.2 Progressive Rehabilitation and Closure Plan

Division 3, Part 2 of Chapter 5 of the EP Act sets out the requirement for an application for an environmental authority to include a proposed PRC Plan. The purpose of the PRC Plan is to (DES, 2019b):

- require an environmental authority holder to plan for how and where activities will be carried out on land in a way that maximises the progressive rehabilitation of the land to a stable condition; and
- require the environmental authority holder to rehabilitate the land in accordance with the PRC Plan and PRCP Schedule.

Information that is required in the PRC Plan includes (DES, 2019b):

- project planning information;
- the proposed PMLUs and NUMAs (non-use management areas);
- consultation activities carried out to develop the PRC Plan;
- rehabilitation and management methods;
- risk assessment; and
- the PRCP Schedule, which is a schedule of binding rehabilitation milestones for each PMLU, and management milestones for each NUMA.



LEGEND

Mining Lease Application Boundary

Railway

Project Component*

- Indicative Infrastructure Area
- Indicative Water Storage
- Indicative Maximum Extent of Open Cut Pit
- Indicative Up-catchment Diversion
- Indicative Mine Access Road
- Indicative Rail Spur and Loop
- Indicative Electricity Transmission Line
- Indicative Raw Water Supply Pipeline
- Indicative Flood Levee

Mine/Rehabilitation Status

- Indicative Advanced Soil Stripping
- Indicative Active Mining
- Indicative Active Emplacement
- Indicative Soil Stockpile

*Note: * Excludes some project components such as water management infrastructure, access tracks, topsoil stockpiles, explosives magazines, power reticulation, temporary offices, other ancillary works and construction disturbance.*

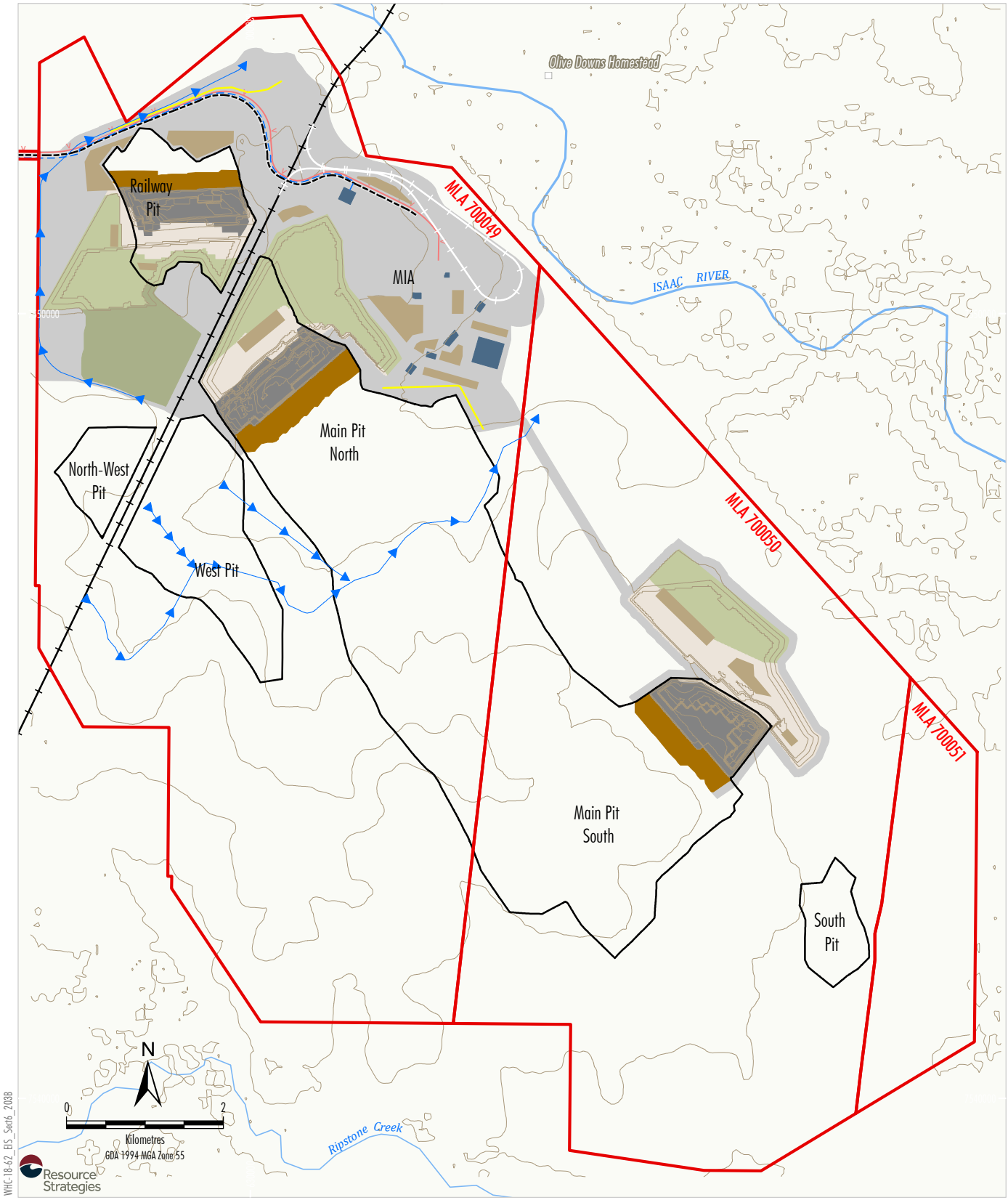
Source: The State of Queensland (2018 - 2020); Whitehaven (2020).

WHITEHAVEN COAL

WINCHESTER SOUTH PROJECT

General Arrangement - Project Year 2

Figure 6-1



LEGEND

Mining Lease Application Boundary

Railway

Project Component*

- Indicative Infrastructure Area
- Indicative Water Storage
- Indicative Maximum Extent of Open Cut Pit
- Indicative Up-catchment Diversion
- Indicative Mine Access Road
- Indicative Rail Spur and Loop
- Indicative Electricity Transmission Line
- Indicative Raw Water Supply Pipeline
- Indicative Flood Levee

Mine/Rehabilitation Status

- Indicative Advanced Soil Stripping
- Indicative Active Mining
- Indicative Active Emplacement
- Indicative Initial Rehabilitation
- Indicative Established Rehabilitation
- Indicative Soil Stockpile

*Note: * Excludes some project components such as water management infrastructure, access tracks, topsoil stockpiles, explosives magazines, power reticulation, temporary offices, other ancillary works and construction disturbance.*

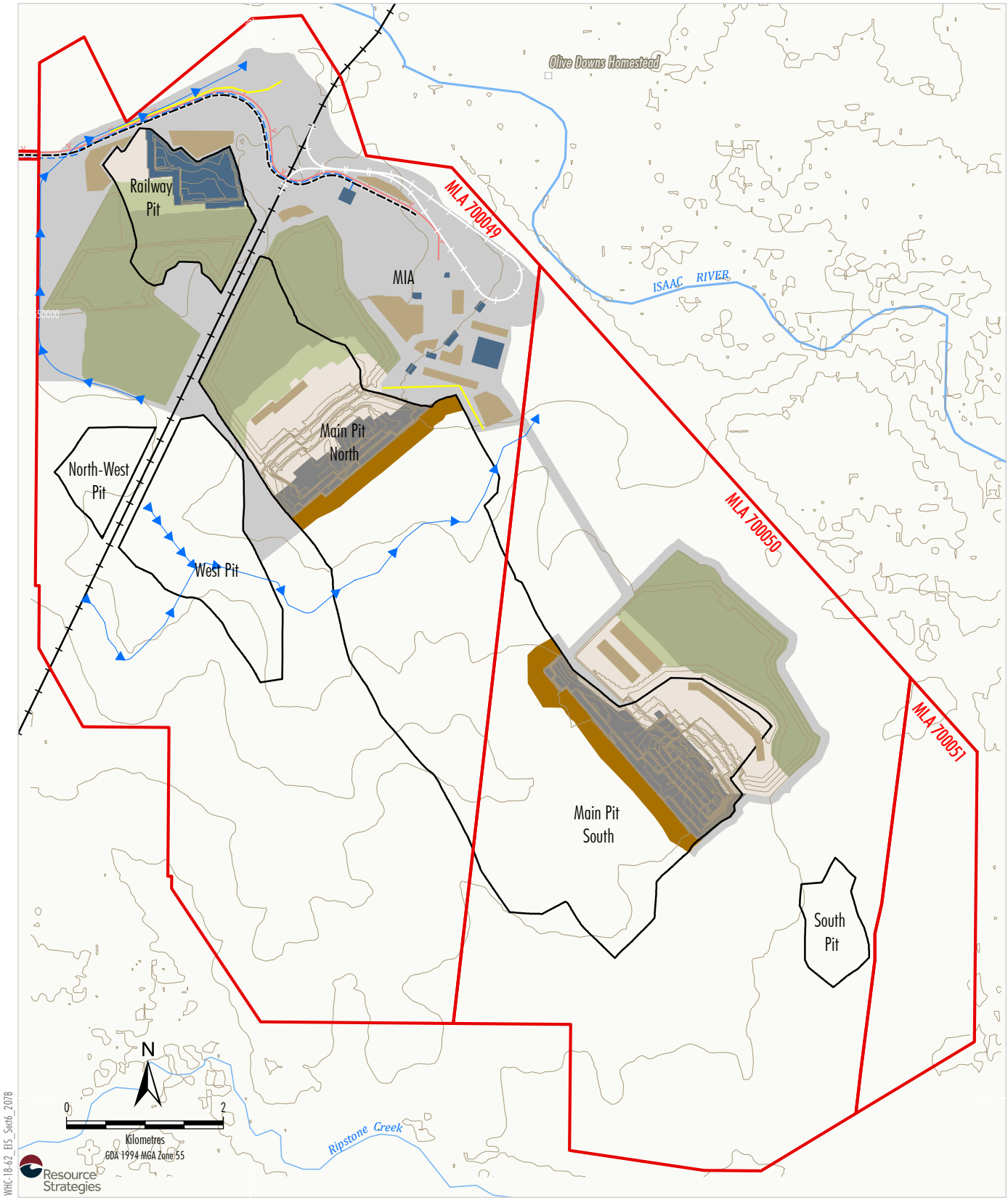
Source: The State of Queensland (2018 - 2020); Whitehaven (2020).

WHITEHAVEN COAL

WINCHESTER SOUTH PROJECT

General Arrangement - Project Year 5

Figure 6-2



LEGEND

Mining Lease Application Boundary

Railway

Project Component*

- Indicative Infrastructure Area
- Indicative Water Storage
- Indicative Maximum Extent of Open Cut Pit
- Indicative Up-catchment Diversion
- Indicative Mine Access Road
- Indicative Rail Spur and Loop
- Indicative Electricity Transmission Line
- Indicative Raw Water Supply Pipeline
- Indicative Flood Levee

Mine/Rehabilitation Status

- Indicative Advanced Soil Stripping
- Indicative Active Mining
- Indicative Active Emplacement
- Indicative Initial Rehabilitation
- Indicative Established Rehabilitation
- Indicative Soil Stockpile

*Note: * Excludes some project components such as water management infrastructure, access tracks, topsoil stockpiles, explosives magazines, power reticulation, temporary offices, other ancillary works and construction disturbance.*

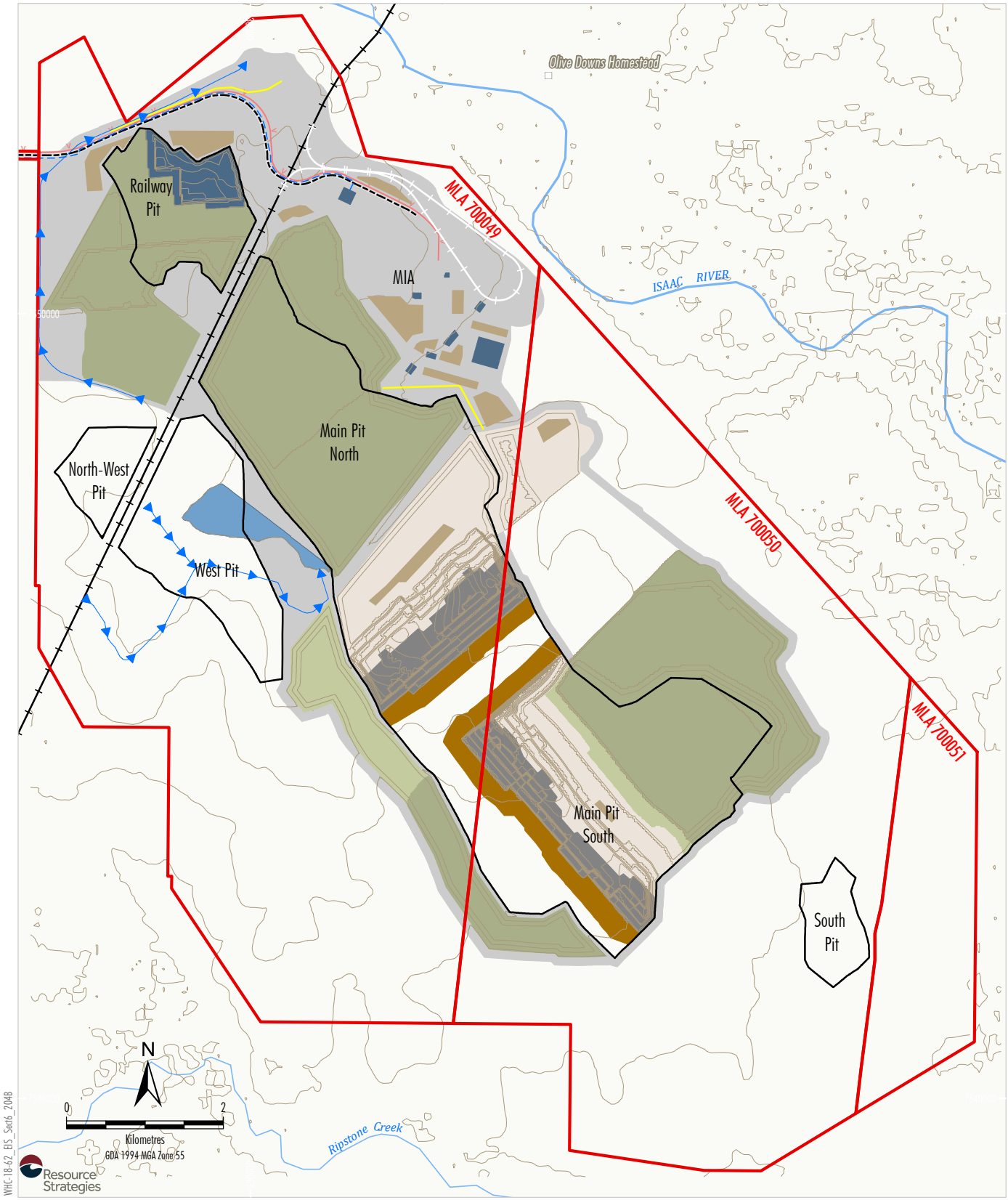
Source: The State of Queensland (2018 - 2020); Whitehaven (2020).

WHITEHAVEN COAL

WINCHESTER SOUTH PROJECT

General Arrangement - Project Year 9

Figure 6-3



LEGEND

Mining Lease Application Boundary

Railway

Project Component*

- Indicative Infrastructure Area
- Indicative Water Storage
- Indicative Clean Water Storage
- Indicative Maximum Extent of Open Cut Pit
- Indicative Up-catchment Diversion
- Indicative Mine Access Road
- Indicative Rail Spur and Loop
- Indicative Electricity Transmission Line
- Indicative Raw Water Supply Pipeline
- Indicative Flood Levee

*Note: * Excludes some project components such as water management infrastructure, access tracks, topsoil stockpiles, explosives magazines, power reticulation, temporary offices, other ancillary works and construction disturbance.*

Mine/Rehabilitation Status

- Indicative Advanced Soil Stripping
- Indicative Active Mining
- Indicative Active Emplacement
- Indicative Initial Rehabilitation
- Indicative Established Rehabilitation
- Indicative Soil Stockpile

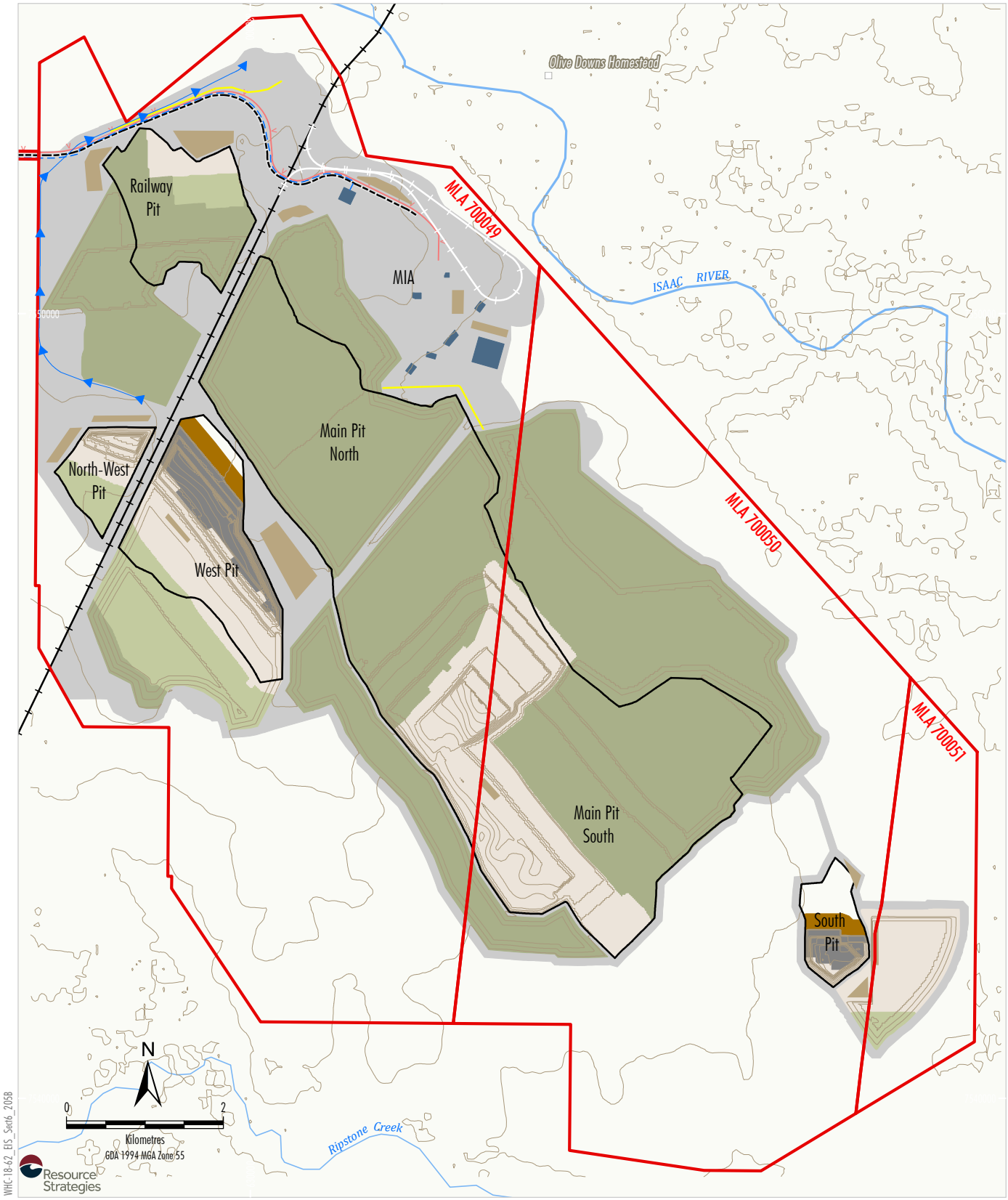
Source: The State of Queensland (2018 - 2020); Whitehaven (2020).

WHITEHAVEN COAL

WINCHESTER SOUTH PROJECT

General Arrangement - Project Year 19

Figure 6-4



LEGEND

Mining Lease Application Boundary

Railway

Project Component*

- Indicative Infrastructure Area
- Indicative Water Storage
- Indicative Maximum Extent of Open Cut Pit
- Indicative Up-catchment Diversion
- Indicative Mine Access Road
- Indicative Rail Spur and Loop
- Indicative Electricity Transmission Line
- Indicative Raw Water Supply Pipeline
- Indicative Flood Levee

*Note: * Excludes some project components such as water management infrastructure, access tracks, topsoil stockpiles, explosives magazines, power reticulation, temporary offices, other ancillary works and construction disturbance.*

Mine/Rehabilitation Status

- Indicative Advanced Soil Stripping
- Indicative Active Mining
- Indicative Active Emplacement
- Indicative Initial Rehabilitation
- Indicative Established Rehabilitation
- Indicative Soil Stockpile

Source: The State of Queensland (2018 - 2020); Whitehaven (2020).

WHITEHAVEN COAL

WINCHESTER SOUTH PROJECT

General Arrangement
- Project Year 27

Figure 6-5

Whitehaven WS lodged an application for a site-specific environmental authority in June 2019 (before the 'PRCP start date'). As such, transitional provisions in the EP Act apply to the environmental authority application for the Project and there is no requirement for this EIS to be accompanied by a proposed PRC Plan.

Instead, Whitehaven WS is required to separately prepare a PRC Plan for the Project in accordance with the timeframes stated in a notice issued by DES after the grant of the environmental authority. As such, this EIS does not contain all the information that will ultimately be the subject of detailed assessment and approval by DES through the PRC Plan process, such as a detailed PRCP Schedule.

Whitehaven WS has developed the Project rehabilitation strategy in consideration of the Terms of Reference and requirements of the *Guideline – Progressive rehabilitation and closure plans (PRC plans)* (DES, 2019b) for transitional projects. Accordingly, the Project has been designed to:

- Be rehabilitated to a safe and stable landform:
  - Waste rock emplacements would be designed with shallow slopes, generally up to 10° (18%), that would be revegetated to minimise erosion and sustain a low-intensity cattle grazing PMLU (Section 6.2.1).
  - Residual void highwalls would be designed to remain stable in the long-term, based on site-specific geological data and geotechnical modelling (Section 6.2.4).
  - Residual void highwalls would be bunded and fenced to prevent access (Section 6.3.2).
- Not cause environmental harm:
  - Residual voids are located outside the extent of predicted flooding events in the Isaac River, up to and including the PMF event (Section 6.2.5).
  - Residual voids would be designed to act as groundwater sinks in perpetuity, preventing the migration of saline water from the residual void lake into adjacent aquifers (Section 6.2.5).
  - Residual void lakes would be designed to equilibrate below the point at which they would spill to the surrounding environment, including when water levels are temporarily increased during a PMP (probable maximum precipitation) storm event (Section 6.2.5).
- Sustain a PMLU:
  - The majority of the Project area would be rehabilitated to sustain the pre-mining land use, predominately low-intensity grazing, consistent with the surrounding area (Section 6.3.1).
  - Current mine scheduling has maximised opportunities for progressive backfilling of open cut pits to improve final land use outcomes and minimise the number and size of residual voids. Two open cut pits would be completely backfilled while four other open cut pits would be partially backfilled and remain as residual voids in the post-mining landform (Section 6.2.3).
  - Residual voids, which include the lake, highwall and low wall areas, are considered unsuitable for a PMLU and are proposed to be NUMAs in the post-mining landform (Section 6.3.2).

6.1.3 Regional Plan and Local Planning Scheme

Section 1.7 of this EIS describes the regional and local context for the Project. Whitehaven WS has developed the Project rehabilitation strategy in consideration of the regional and local planning strategies, and in consultation with the community.

Mackay, Isaac and Whitsunday Regional Plan

The Project is located within zones identified and mapped as Regional Landscape and Rural Production Area under the *Mackay, Isaac and Whitsunday Regional Plan* (Department of Local Government and Planning, 2012).

The *Mackay, Isaac and Whitsunday Regional Plan* establishes a vision and direction for the region to 2031 and includes the following strategic directions considered relevant to the Project rehabilitation strategy:

> ***Regional landscapes***
>
> *Regional landscapes include the Great Barrier Reef; continental islands, rocky headlands and fringing reefs; coastal plains; cane fields; the Connors and Clarke ranges; the western coalfields around Moranbah, Dysart and Nebo; bluegrass downs; inland river systems such as the Suttor and Belyando; and the desert uplands at the western boundary of the region. These landscapes are the basis of the social, economic, tourism and cultural values of the region.*

Natural resource management

The region's plentiful natural resources include productive agricultural land, freshwater systems, air, native plants and animals, minerals, and marine waters. These resources underpin the region's economy, and support the diverse range of industry and business opportunities that rely on their quality and accessibility.

The Project rehabilitation strategy is considered to be consistent with the *Mackay, Isaac and Whitsunday Regional Plan* in that:

- The proposed Project final landform and low-intensity grazing PMLU would provide ongoing access to and utilisation of agricultural lands, minimise impacts on freshwater systems, and integrate with the regional landscape (Sections 6.2 and 6.3).
- The proposed PMLU of low-intensity grazing would enable the Project area to continue to contribute to underpinning the region's economy and provide industry and business opportunities.

Local Planning Scheme

The Project is located within the Isaac Regional Council LGA. At its meeting on 24 February 2021, the Isaac Regional Council adopted a new planning scheme, the *Isaac Regional Planning Scheme 2021*, which was gazetted on 19 March 2021 and came into effect on 1 April 2021 (Section 1.7).

The *Isaac Regional Planning Scheme 2021* includes the following strategic and policy intentions for the region that are considered relevant to the Project rehabilitation strategy:

3.2.2 Isaac Region in 2036

…

(15) The region's economy, in addition to the positive contribution from mining activities, includes thriving rural enterprises incorporating cattle grazing and cropping activities and a wide range of complementary value adding rural industries and diversified tourism activities within the capacity of rural infrastructure networks.

…

(22) The region's natural environment supports recreation and cultural activities, tourism and primary production in keeping with the environmental values.

(23) Development and infrastructure mitigates impacts on cultural heritage, water quality and natural environmental values.

(24) Land use and land management practices support improvements to water quality in the catchments of the Fitzroy, Burdekin, Styx and a small area of the Pioneer River and Plane Creek which flow to water supply catchments and the Great Barrier Reef.

…

3.5.1.2 Extractive, mineral, gas and petroleum resources

…

(4) Extractive resource operations only occur where compatible with the intentions of the relevant zone and overlays applying to the site, and where impacts on visual amenity, the natural environment including Matters of State Environmental Significance or the safety and amenity of the surrounding area can be mitigated to an acceptable standard.

(5) Extractive resource operations whether within a KRA [Key Resource Area] *or not are managed to avoid or mitigate to an acceptable standard, impacts including impacts on visual amenity, the natural environment and water quality and offsite impacts on adjoining uses caused by noise, dust, light, blasting or vibration.*

(6) Resource extraction areas are progressively rehabilitated following extraction to restore the natural environment and to mitigate environmental impacts including impacts associated with dust.

The Project rehabilitation strategy is considered to be generally consistent with the *Isaac Regional Planning Scheme 2021*, in that:

- Progressive rehabilitation of areas disturbed by the Project would minimise potential adverse impacts on air quality, water quality and soil condition (Section 6.5).
- The proposed Project final landform would minimise adverse effects on the Isaac River given that residual voids would be designed to be located outside the extent of all predicted flood events and progressive rehabilitation would minimise erosion.
- Progressive rehabilitation and the proposed low-intensity grazing PMLU would minimise potential impacts on visual amenity by integrating with the surrounding landscape and predominant existing land use in the region.

6.2 CONCEPTUAL FINAL LANDFORM

Whitehaven WS has considered several final landform design options for the Project. An assessment of these options is provided in Section 3.7.1. This Section (Section 6.2) provides additional details on Whitehaven WS's preferred option.

The proposed Project final landform would comprise rehabilitated waste rock emplacements, former infrastructure areas and former open cut pits that have been completely backfilled (i.e. where no residual void would remain) or partially backfilled to become residual voids.

The conceptual layout of the proposed final landform for the Project is shown on Figure 6-6.

6.2.1 Waste Rock Emplacements

Waste rock produced by mining would initially be placed in out-of-pit waste rock emplacements located adjacent to the open cut mining areas (Section 2.5.9). When sufficient space is created within mined-out areas, waste rock would be used to completely or partially backfill the Project open cut pits. Accordingly, waste rock emplacements would be both elevated above, level with, and below, the natural ground level. The completely backfilled Railway Pit and Main Pit North would be rehabilitated consistent with the rehabilitation concepts for rehabilitation of waste rock emplacements.

Waste rock emplacement areas would be progressively shaped and prepared for rehabilitation activities (i.e. final contouring, soil placement and revegetation) as soon as practicable after the area becomes available.

In consideration of best practice landform design, to improve rehabilitation outcomes and minimise slope instability, waste rock emplacements have been designed:

- with slope angles of up to approximately 10° (18%);
- to incorporate small, contoured embankments that minimise overall slope length;
- with gently sloped surfaces on the elevated plateau, shaped so that rainfall runoff does not accumulate on the emplacement; and
- to allow soil placement, ripping and revegetation (and fertilisation if required) activities to be carried out as soon as practicable, after landform shaping is complete.

Further consideration of the geotechnical stability of the final landform, including waste rock emplacements, is described in Section 6.2.4. Revegetation concepts for the waste rock emplacements are described in Section 6.4.7.

The design of waste rock emplacements may be revised to adopt developments in best-practice methodologies throughout the life of the mine. This would be detailed in the Project PRC Plan process.

6.2.2 Infrastructure Areas

All infrastructure associated with the Project would be assessed on an individual basis and either decommissioned and removed, or with landowner consent retained for future use as part of the PMLU. Any retained infrastructure would be commensurate with the low-intensity grazing PMLU and may include (but would not be limited to) dams, access roads and fences.

Where infrastructure is decommissioned and removed, the land would be shaped, topsoiled, ripped and revegetated. Disturbed areas would be rehabilitated with an appropriate seed mix to enable revegetation as described in Section 6.4.7.

Decommissioning and mine closure is discussed further in Section 6.4.2.

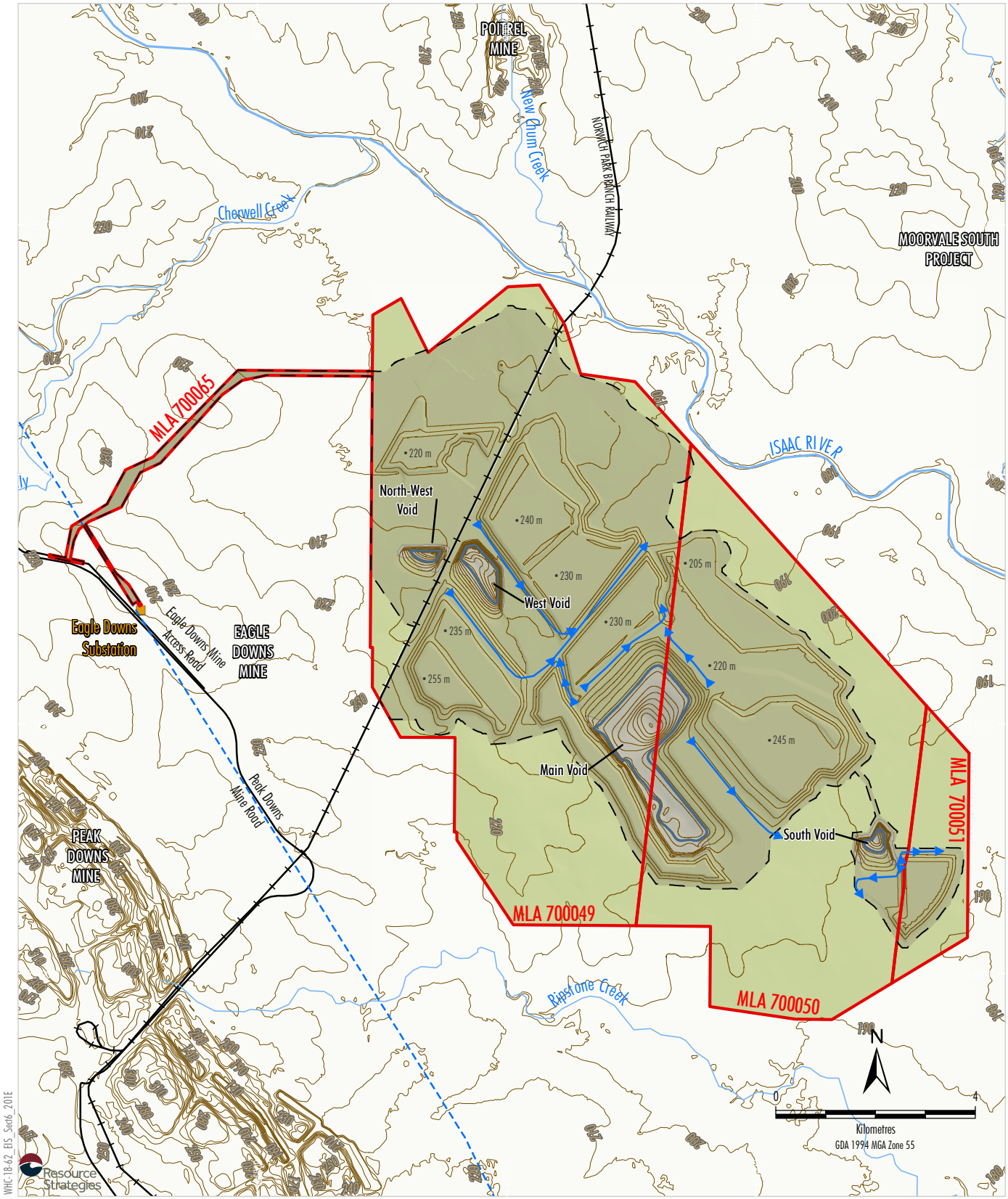
6.2.3 Residual Voids

Waste rock would be emplaced within the mine open cut pits behind advancing mine operations (Section 2.5.5).

The Project schedule has been optimised so that backfilling of open cut pits occurs progressively, and the number and extent of residual voids is minimised, and residual voids are located outside the extent of the Isaac River floodplain (Figure 6-7), up to and including the PMF event.

Table 6-1 summarises the rehabilitation concepts for the open cut pits. All open cut pits would either be completely or partially backfilled, with four residual voids remaining in the final landform (Figure 6-6). A conceptual cross section of the proposed residual voids for the Project is shown on Figure 6-8.

Perimeter bunding or fencing would be installed to restrict access to the residual voids in the final landform.



LEGEND

- Mining Lease Application Boundary
- Indicative Surface Disturbance Extent
- Indicative Residual Void Lake
- Indicative Extent of Non-Use Management Area
- Indicative Extent of Rehabilitation to Low-Intensity Grazing Post-Mining Land Use*
- Land Outside Indicative Surface Disturbance Extent with a Low-Intensity Grazing Post-Mining Land Use
- Contours (10 m)
- Indicative Surface Water Drain

*Note: * Should the Winchester Quarry remain at the end of the Project life, the PMLU for its extent would be quarrying and not low-intensity grazing.*

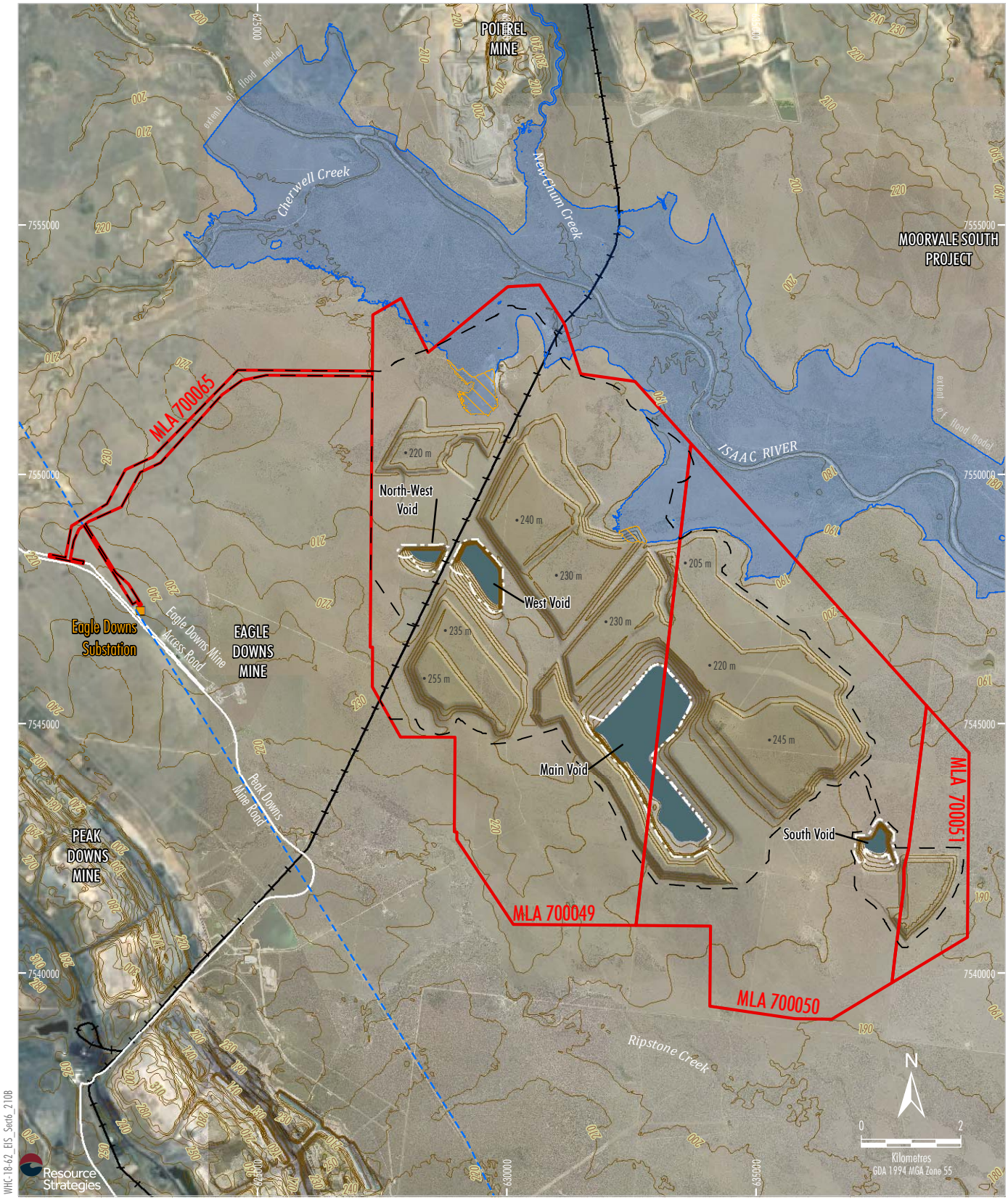
Source: The State of Queensland (2018 - 2020); Whitehaven (2020).

WHITEHAVEN COAL

WINCHESTER SOUTH PROJECT

Conceptual Final Landform and Land Use

Figure 6-6



LEGEND

- Mining Lease Application Boundary
- Railway
- Eungella Water Pipeline Southern Extension
- Substation
- Indicative Surface Disturbance Extent
- Isaac River 0.1% AEP Flood Extent (Pre-mining)
- Change in Flood Extent Due to the Project (Post-mining)
- Indicative Extent of Non-Use Management Area
- Indicative Residual Void Lake

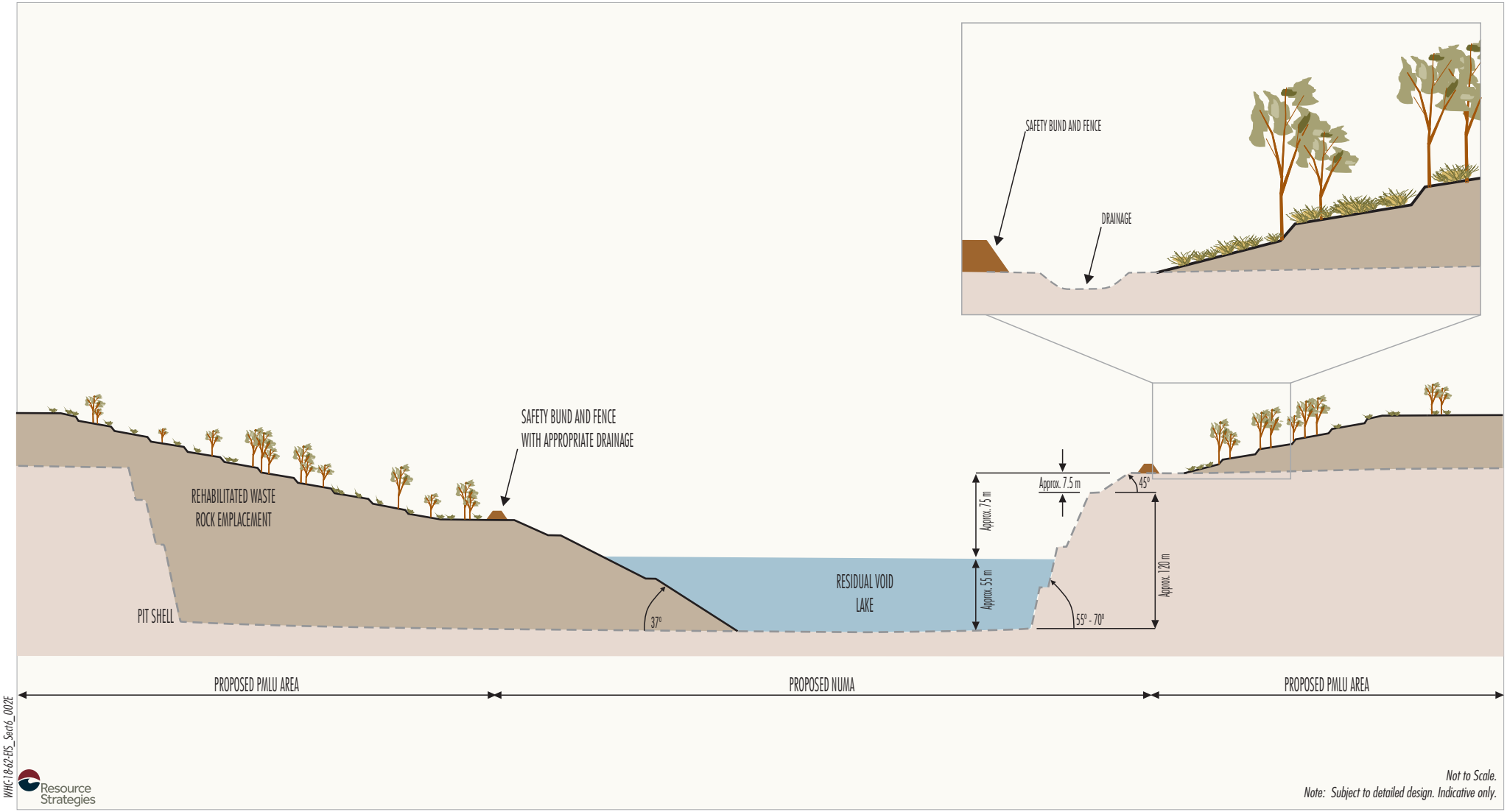
Source: The State of Queensland (2018 - 2020); Whitehaven (2020); WRM (2021). Orthophoto: Google Image (2019); Whitehaven (2017).

WHITEHAVEN COAL

WINCHESTER SOUTH PROJECT

Location of the Residual Voids in Relation to the Pre-mining 0.1% AEP Flood Extent of the Isaac River

Figure 6-7



Source: Whitehaven (2020).

WHITEHAVEN COAL

WINCHESTER SOUTH PROJECT

Indicative Residual Void Cross-section

Figure 6-8

Table 6-1
Status of Open Cut Pits at Mine Closure

Open Cut Pit	Status	Minimum Depth (mbgl)
Railway Pit	Completely backfilled	-
Main Pit North	Completely backfilled	-
Main Pit South	Partially backfilled with residual void (referred to as 'Main Void' herein)	119
North-West Pit	Partially backfilled with residual void (North-West Void)	99
West Pit	Partially backfilled with residual void (West Void)	119
South Pit	Partially backfilled with residual void (South Void)	95

6.2.4 Geotechnical Stability

A preliminary geotechnical stability assessment for the Project was prepared by Blackrock Mining Solutions (2020). The assessment focused on identifying geotechnical stability limits for the Project final landform. This included analysis of residual void highwalls and waste rock emplacement slopes. The assessment was based on the Project final landform design and supported by historical geotechnical reports and drilling data (Blackrock Mining Solutions, 2020).

Recommendations from the preliminary geotechnical assessment have been adopted as either design criteria for the Project landform or commitments for management and further assessment during Project operation. These include (Blackrock Mining Solutions, 2020):

- To achieve the required factor of safety, residual void highwalls would have maximum batter angles of up to 45° in the Cenozoic horizon, 55° in the weathered Triassic/Permian horizon, and up to 70° in the fresh Triassic/Permian horizon. Assuming the presence of 20 m wide benches constructed at appropriate heights, the average angle of residual void highwalls would be approximately 50° from crest to toe.
- Safety perimeter bunding or fencing would be installed around the crest of highwalls to accommodate degradation or slope failure over time. Drainage systems would be installed to protect any perimeter bunding and residual void crests.
- Further geotechnical assessment would be carried out during Project operation to further refine the residual void design. This assessment would be undertaken as part of the progressive rehabilitation and mine closure planning process.
- Monitoring would be undertaken to evaluate the predicted geotechnical stability of the final landform.

The maximum batter angles for the Cenozoic horizon (presented above) are greater than those recently conditioned in the Environmental Authority for the adjoining Olive Downs Project. This is due to a relatively thin Cenozoic horizon present across the Project area, generally limited to between 2.5 m and 7.5 m in depth.

The preliminary geotechnical assessment concluded that (Blackrock Mining Solutions, 2020):

> ***The proposed final landform design exceeds the minimum FoS [factor of safety] of 1.5 for long-term stability, based on the assumptions, and is therefore acceptable from a geotechnical perspective.***

Separate to the above, to improve the Project final landform and assist with the establishment of a low-intensity grazing PMLU on waste rock emplacements outside of residual voids, slopes of waste rock emplacements would be limited to up to approximately 10° (18%). Section 6.3.1 provides further detail in this regard.

6.2.5 Surface Water and Groundwater

The final landform would be designed to minimise the surface catchment area of the residual voids. Surface water drainage would be constructed to direct runoff from the final landform, as well as up-catchment runoff, to the surrounding landscape and the Isaac River (Figure 6-6). Section 6.4.6 describes the rehabilitation activities proposed to establish suitable drainage of the Project final landform.

After mining, groundwater would flow into and accumulate within the residual voids. Long-term residual void water levels were modelled as part of the Groundwater Assessment (Appendix A) and Surface Water and Flooding Assessment (Appendix B).

Each residual void lake is predicted to equilibrate at different levels. Long-term equilibrated water levels are predicted to be approximately (Appendix A):

- 162 mAHD in North-West Void;
- 128 mAHD in West Void;
- 161 mAHD in Main Void; and
- 142 mAHD in South Void.

The Surface Water and Flooding Assessment (Appendix B) also predicted that residual void water levels would temporarily increase by approximately 6 m to 12 m during the probable maximum precipitation event.

Predicted equilibrated residual void water levels are between approximately 47 m to 74 m below their respective full supply levels (i.e. the levels above which spill to the surrounding environment would occur).

Based on the findings in Appendices A and B, the residual voids are not predicted to spill and present negligible risk of water within the residual voids interacting with the surrounding environment.

Salt occurring naturally in the Project groundwater systems would also enter the residual voids. Evaporation from the residual void lakes would lead to the accumulation of salt over time.

Water balance modelling predicts that all Project residual voids would remain brackish for approximately 20 to 30 years after mining, becoming hypersaline (i.e. >84,600 µS/cm) approximately 150 to 200 years after mining, and ultimately reaching the following peak salinity levels (Appendix B):

- North-West Void – approximately 215,500 µS/cm;
- West Void – approximately 163,700 µS/cm;
- Main Void – approximately 147,500 µS/cm; and
- South Void – approximately 183,600 µS/cm.

The predicted equilibrated residual void water levels are between approximately 23 m to 58 m below the surrounding groundwater table, and therefore the residual voids would act as sinks to groundwater flow (Appendix A). Further discussion on residual void water levels in relation to the surrounding groundwater table, including consideration of partial backfill, is included in Section 3.7.

As the residual voids would act as groundwater sinks, saline water within the residual void would be prevented from migrating to the surrounding aquifer.

The Surface Water and Flooding Assessment (Appendix B) modelled flood water level and velocity in the Isaac River under pre- and post-mining conditions, and concluded that residual voids are located outside the extent of the Isaac River floodplain at closure, up to and including the PMF event.

The Surface Water and Flooding Assessment also concluded that the small areas where the 1 in 1,000 AEP flood extent interacts with rehabilitated waste rock emplacements in the final landform, peak velocity is generally less than 0.3 m/s.

Based on these findings, the Project final landform is considered to result in no increased risk of erosion (compared to pre-mining conditions) to the Isaac River floodplain for the 1 in 1,000 AEP flood event.

6.2.6 Geochemistry

An assessment of the predicted geochemical characteristics of waste rock and coarse reject material has been prepared by Terrenus (2020) (Appendix M).

The assessment found that Project waste rock is expected to (Appendix M):

- be primarily NAF with excess ANC, and therefore would have negligible risk of developing acid conditions;
- generate surface water runoff and seepage, of low to moderate salinity, with low soluble metal concentrations; and
- be sodic, with some potential for dispersion and varying degrees of erosion.

Project coarse reject is expected to generate water runoff and seepage that is pH neutral to alkaline and of low salinity following initial surface exposure.

Based on the findings of the geochemistry assessment and recommendations provided by Terrenus (2020), the following measures would be undertaken to manage waste rock and coal rejects throughout operations and post-mining:

- Where highly sodic and dispersive waste rock material is identified, it would be selectively handled and, where practicable, excluded from the upper surface of waste rock emplacements in the final landform.
- Waste rock emplacements would be designed with shallow slopes and progressively rehabilitated to minimise erosion.
- Coarse rejects would be covered by at least 10 m of inert waste rock.
- Surface water runoff and seepage from waste rock emplacements would be monitored for pH, EC, major anions (sulfate, chloride and alkalinity), major cations (sodium, calcium, magnesium and potassium), salinity and various soluble metals.

Based on the above described measures and the conclusions of the geochemistry assessment, waste rock and coarse reject material would be managed to achieve the rehabilitation goal of the final landform being safe, stable, non-polluting and able to sustain the proposed low-intensity grazing PMLU.

6.3 PROPOSED LAND OUTCOMES

6.3.1 Post-Mining Land Use

In consideration of the requirements of the *Mined Land Rehabilitation Policy* (DEHP, DNRM and Queensland Treasury, 2017), Whitehaven WS has considered suitable potential PMLUs for the Project, having regard to the surrounding landscape, existing land uses, community views and the objectives of the relevant local and regional planning strategies.

Surrounding Landscape

Land within the Project area has been largely cleared through past agricultural and quarrying practices and is used predominantly for cattle grazing. The largest tracts of remnant vegetation in the Project area and surrounding landscape exist along the riparian corridor of the Isaac River.

The landscape surrounding the Project area includes multiple existing and approved mining operations (that are predominantly open cut), coal and petroleum exploration activities, and land used for cropping and livestock grazing.

Relevant Regional Plans

The *Mackay, Isaac and Whitsunday Regional Plan* (Department of Local Government and Planning, 2012) mapped land within the Project area and surrounds as "regional landscape and rural production area". The designation "regional landscape and rural production" does not impede existing land use rights so that existing commitments and significant activities, such as agricultural production, access to natural resources, mineral extraction and/or nature conservation, can continue (Department of Local Government and Planning, 2012).

Grazing is an existing land use and, as such, would be consistent with the intent of "regional landscape and rural production".

Local Planning Strategies

Land within the Project area is identified as a 'rural' in the *Isaac Regional Planning Scheme 2021*. Section 3.2.3 of the Scheme defines grazing as a use that is consistent with the 'rural preferred use' area.

Community Views

The proposed low-intensity grazing PMLU over the majority of the Project area was discussed as part of consultation activities undertaken by Whitehaven WS for the Project. Attachment 4 of the EIS describes the consultation activities in more detail.

Further, it is considered that the *Isaac Regional Planning Scheme 2021* broadly represents the views of the community in relation to appropriate land uses within and surrounding the Project. The Project rehabilitation strategy is considered to be generally consistent with the Planning Scheme (Section 6.1.3).

Land Suitability

GTE (2021) completed a land suitability assessment and concluded that the majority of the final landform would be suitable as Class 3 for grazing (Appendix J).

Post-Mining Land Use – Low Intensity Grazing

Low-intensity grazing is considered to be a suitable use for the portions of the Project area that are proposed to have a PMLU given:

- It is viable having regard to land uses in the region and is consistent with the existing (pre-mining) land use within the Project area and surrounding landscape.
- Low-intensity grazing would not result in increased potential for harm to the surrounding environment.
- Grazing as a PMLU is considered to be consistent with the social, economic and environmental objectives of relevant regional plans, local planning strategies and community views (Section 6.1).

In accordance with the *Mined Land Rehabilitation Policy* (DEHP, DNRM and Queensland Treasury, 2017), the Project would be progressively rehabilitated as land becomes available. Rehabilitation progress would be monitored against milestones and completion criteria to demonstrate successful rehabilitation of the Project (Section 6.6).

Waste emplacement landforms would be re-graded to have slopes of up to approximately 10° (18%) and contain a mixture of pasture and woodland species.

Revegetation would occur in a manner that results in patches of woodland in pasture areas to facilitate the ongoing use of the land for low-intensity grazing. Pasture species would be either native and improved pasture species, or other appropriate species suited to the Project final landforms. Woodland species used for rehabilitation would be suitable for the region and/or local provenance. Proposed pasture and woodland species are described in more detail in Section 6.4.7.

Infrastructure associated with the Project, such as access roads, fencing or water management infrastructure, may be retained for future use as part of the PMLU. Any infrastructure proposed to be retained in the final landform would be determined in consultation with the relevant government agencies and the ultimate land owner. Proposed infrastructure decommissioning activities are described in Section 6.4.2.

The proposed PMLU would encompass the mining lease areas (excluding the proposed NUMAs) shown on Figure 6-9.

6.3.2 Non-Use Management Area

The post-mining landform would include four residual voids made up of a lake and low wall and highwall components (Section 6.2.3). These residual voids are proposed to be NUMAs.

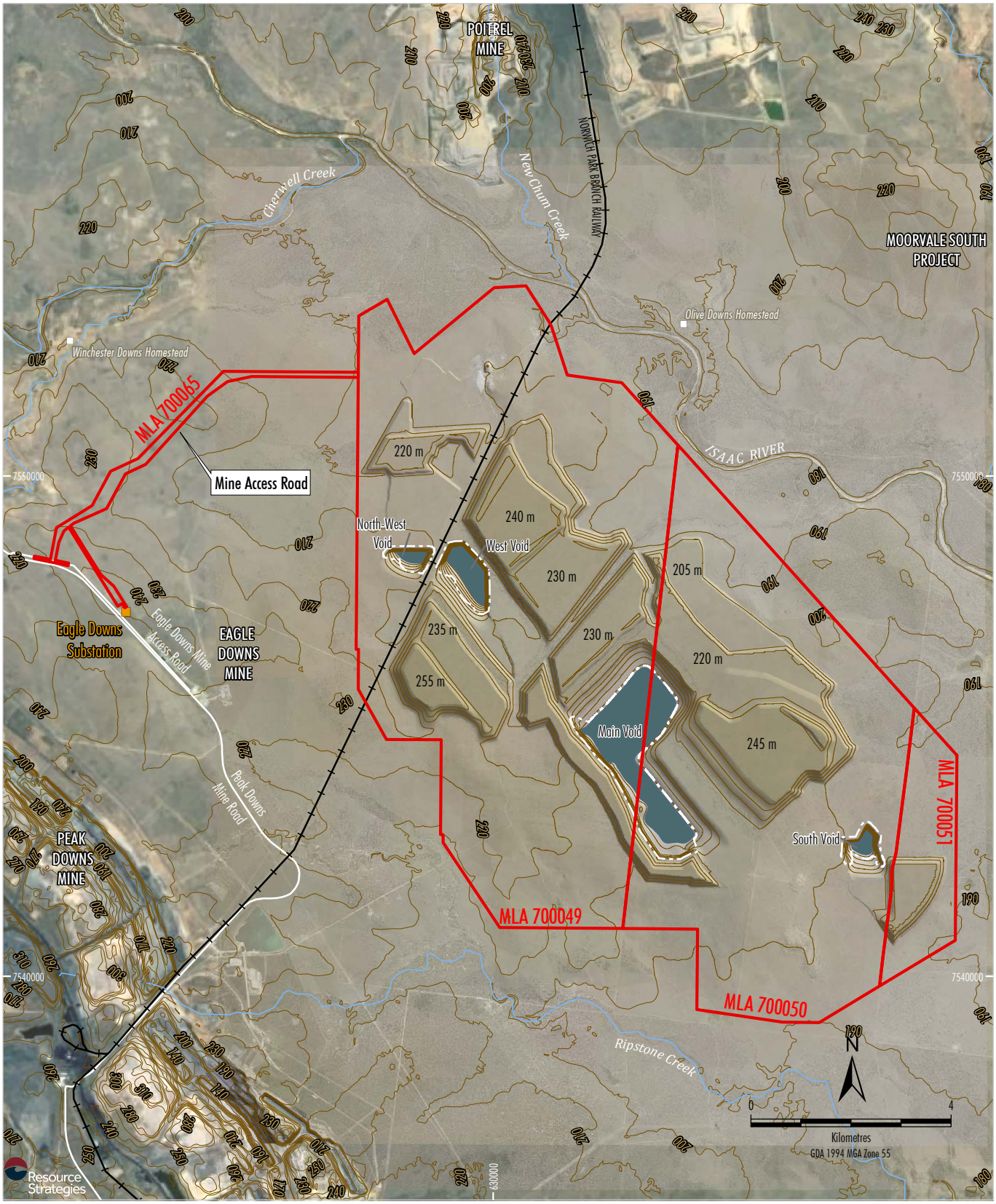
Whitehaven WS has considered the requirements of section 126D(2) of the EP Act and the potential PMLU options for the residual voids. It is in the public interest that the residual voids are NUMAs, because:

- the footprint and location of the NUMAs would be designed to minimise environmental impact;
- the residual voids would be designed to operate as groundwater sinks, preventing any salinity that accumulates over a long period of time from migrating into the surrounding aquifers;
- keeping the residual voids in perpetuity would not present any risk of environmental harm outside of the Project area;
- the residual voids would not be located within the floodplain;
- there is no public interest outside of the direct footprint of the residual voids that would be harmed as a result of retaining them in perpetuity;
- the residual voids would be made safe, stable and non-polluting;
- completely back filling all residual voids would render the Project commercially unfeasible (Section 3.7.1); and
- there is therefore a net public benefit to retain the residual voids as NUMAs in perpetuity.

A summary of these considerations is provided below.

Residual Void Water Quality

Water balance modelling predicts that residual void water quality will increase in salinity over time and lakes would remain brackish for approximately 20 to 30 years after mining, becoming hypersaline approximately 150 to 200 years after mining, and ultimately reaching peak salinity levels of approximately 147,500 µS/cm to 215,500 µS/cm (Section 6.2.3).



LEGEND

- Mining Lease Application Boundary
- Indicative Extent of Non-Use Management Area
- Indicative Residual Void Lake
- Contours (10 m)

Source: The State of Queensland (2018 - 2020); Whitehaven (2020).

WHITEHAVEN COAL

WINCHESTER SOUTH PROJECT

Conceptual Final Landform - Aerial

Figure 6-9

When assessing the beneficial use of residual void lakes, Whitehaven WS considered the following to be relevant:

- The *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZG, 2018) provides tolerance levels of livestock to salinity in drinking water, including that a loss of production and animal condition occurs from drinking water with salinity levels above 5,000 mg/L (approximately 7,460 µS/cm).
- There is some evidence suggesting that saline and hypersaline environments provide habitat for native flora and fauna. For example, ducks are known to use saline environments as drought refuge (Lavery, 1972), and hypersaline environments by drinking freshwater from elsewhere (Hart *et al.*, 1991). Additionally, some plant species are known to grow around the edges of hypersaline lakes (Hart *et al.*, 1991).
- Notwithstanding, there is a general lack of evidence that hypersaline lakes with salinity levels up to 215,500 µS/cm (as is predicted for the Project) would provide native flora and fauna habitat on an ongoing basis.
- Contemporary research initiatives that the mining industry is carrying out (such as ACARP Project C27043) are seeking to better understand the potential benefits of residual void lakes to native flora and fauna.
- Other potential benefits of residual void lakes may include water supply for bushfire management or for other nearby mining operations.

In consideration of the above, the Project residual voids are likely to provide habitat for native flora and fauna for the period over which salinity levels are predicted to be brackish (i.e. up to approximately 20 years after mining), and may provide habitat while salinity levels are predicted to be saline (i.e. up to approximately 150 years after mining).

However, Whitehaven WS considers that, on the basis of information currently available, the residual void lakes would not provide an ongoing source of habitat for native flora and fauna once they are hypersaline.

Additionally, Whitehaven WS considers that the use of the residual void lakes as a potential water supply for other nearby mining operations is currently unviable considering the infrastructure likely required.

Based on the above, Whitehaven WS considers that it is not technically or economically viable to achieve a PMLU for the residual void lakes and proposes that residual void lakes would form NUMAs in the final landform.

If an ongoing beneficial use of the Project residual voids is identified in future, such as through the findings of research initiatives, Whitehaven WS would consider this as part of rehabilitation and closure planning activities for potential inclusion in the Project PRC Plan.

Highwall and Low Wall Areas

Residual void highwalls would have maximum batter angles of 45° to 70°, depending on the underlying geology. With 20 m wide benches (determined during ongoing geotechnical studies), the average angle of residual void highwalls would be approximately 50° from crest to toe (Figure 6-8).

Residual void low walls which adjoin waste rock emplacements would have a maximum batter angle of up to 37°. With 25 m wide benches constructed at appropriate heights, the average angle of residual void low walls would be approximately 25° from crest to toe (Figure 6-8).

When assessing the beneficial use of residual void highwall and low wall areas, Whitehaven WS considered the following to be relevant:

- Post-mining landforms with slopes of up to 10° (18%) are generally considered suitable for grazing. However, pasture growth and allowable stocking rate is influenced by land slope in combination with other physical and chemical characteristics of the landform (Grigg *et al*., 2002; Grigg *et al.*, 2006).
- In a review of grazing PMLUs at three rehabilitated mines in the Bowen Basin, slopes of up to 10° (18%) were identified as being suitable to sustain low-intensity stocking rates of between 2.2-5.9 hectares/head (*Sustainable Grazing on Rehabilitated Lands in the Bowen Basin* [ACARP, 2002]).

The steeper parts of the residual void highwalls and low walls may provide habitat for some fauna species (e.g. bird roosting or nesting). However, until these potential uses are demonstrated, Whitehaven WS does not consider it appropriate or economically viable to commit to their success at this early stage in the Project.

In consideration of the above, Whitehaven WS proposes that the residual void highwalls and low walls with slopes greater than 10° (18%) would not be suitable for the intended low-intensity grazing PMLU and would therefore form NUMAs in the final landform.

As per the approach for residual void lakes, if additional data becomes available that means that a fauna habitat completion criteria commitment is technically and economically viable, Whitehaven WS would consult with the DES on the potential to update the land use commitments for highwalls and low walls as part of the PRC Plan process.

Proposed NUMA Extent

To minimise risks to people and livestock, the proposed NUMA extent would include a safety buffer distance of 20 m from the crest of residual void highwalls, low walls with slope greater than 10° (18%), and the residual void lake (inclusive of the 1 in 1,000 AEP rainfall event).

In accordance with the *Mined Land Rehabilitation Policy* (DEHP, DNRM and Queensland Treasury, 2017):

- the NUMAS have been minimised to the greatest extent practicable by minimising the catchments that report to the residual voids by using up-catchment diversion drains (Appendix B). By reducing the catchments that report to the residual voids, the equilibrated water bodies are reduced, thereby reducing the extent of the NUMAS; and
- the potential for environmental harm associated with the NUMAs has been minimised as the residual voids and NUMAs would be located outside of the Isaac River floodplain (Figure 6-7), minimising the potential for environmental harm associated with overflow or inundation during a flood event. The reduction in catchment areas that report to the residual voids also minimises the potential for environmental harm associated with the voids.

Furthermore, the Surface Water and Flooding Assessment concludes that the potential impact on water quantity in the Isaac River and Ripstone Creek due to the final landform (i.e. the catchment excised by the residual voids) is considered to be negligible and impacts to aquatic ecosystems downstream of the Project area, or aquatic ecological values of the receiving environment, as a result of changes to water quality of flow regime are not expected (Sections 4.2.3 and 4.5.3).

Additionally, the open cut pits of the Project do not intercept the Isaac River alluvium (Appendix A).

The number and extent of residual voids for the Project has also been minimised, with two open cut pits (Railway Pit and Main Pit North) being fully backfilled during life of the mine.

Protective bunding, fencing and signage would be installed around the perimeter of the proposed NUMA extent. The risk of any environmental harm arising as a result of not carrying out the rehabilitation of the relevant residual voids to a PMLU is confined to the Project area.

The proposed extent of NUMAs within the Project final landform is shown in Figure 6-9. The risk of any environmental harm arising as a result of not carrying out rehabilitation of the relevant residual voids to a PMLU is confined to the Project area.

The residual void design would be periodically reviewed in consultation with relevant government agencies as part of mine closure planning for the Project (i.e. through the PRC Plan).

6.3.3 Summary

The proposed land outcome for the Project is summarised in Table 6-2. The majority of the total Project open cut pit area (approximately 3,037 ha) would be backfilled and rehabilitated to a low-intensity grazing PMLU, with only approximately 576 ha proposed to be a NUMA (including approximately 360 ha of residual void lake).

In regard to tenure, the Project area is made up of freehold land (Section 2.2.1) and would remain freehold land at the end of the Project life, subject to agreements with the relevant landholders.

6.4 GENERAL REHABILITATION ACTIVITIES

General rehabilitation practices and measures that would be implemented for the Project are described in the following sub-sections. Detailed descriptions of practices and measures would be provided in the Project PRC Plan.

Table 6-2
Proposed Land Outcome for Project Open Cut Pits

Open Cut Pit	Proposed Land Outcome[1]
Railway Pit	Completely backfilled with 100% of open cut pit (247 ha) rehabilitated to low-intensity grazing PMLU.
Main Pit North	Completely backfilled with 100% of open cut pit (1,031 ha) rehabilitated to low intensity grazing PMLU.
Main Pit South	Partially backfilled with 67% of open cut pit (819 ha) rehabilitated to low-intensity grazing PMLU. The remaining 33% (400 ha) is proposed to be a NUMA (291 ha of which is the residual void [Main Void] lake).
North-West Pit	Partially backfilled with 60% of open cut pit (57 ha) rehabilitated to low-intensity grazing PMLU. The remaining 40% (38 ha) is proposed to be a NUMA (10 ha of which is the residual void lake).
West Pit	Partially backfilled with 74% of open cut pit (259 ha) rehabilitated to low-intensity grazing PMLU. The remaining 26% (92 ha) is proposed to be a NUMA (46 ha of which is the residual void lake).
South Pit	Partially backfilled with 51% of open cut pit (48 ha) rehabilitated to low-intensity grazing PMLU. The remaining 49% (46 ha) is proposed to be a NUMA (12 ha of which is the residual void lake).

[1] Percentages are approximate based on plan view area.

Rehabilitation progress and effectiveness of rehabilitation practices would be regularly evaluated based on rehabilitation monitoring results. These results would be used to inform future rehabilitation initiatives and refinement of the rehabilitation practices and measures described below.

6.4.1 Progressive Rehabilitation

In accordance with the *Mined Land Rehabilitation Policy* (DEHP, DNRM and Queensland Treasury, 2017), the Project would be progressively rehabilitated during mining according to the Project schedule of works (Section 2.1.8) to achieve a stable and non-eroding land surface over time and the objectives of the proposed low-intensity grazing PMLU (Section 6.6).

Progressive development and rehabilitation of the Project is shown on Figures 6-1 to 6-5.

Rehabilitation progress would be monitored against milestones and completion criteria to demonstrate successful rehabilitation of the Project (Section 6.6).

6.4.2 Decommissioning and Mine Closure

As described in Section 2.1.8, mining operations would ramp down over the last three years of the Project. This ramp-down phase of the Project would provide opportunity to flexibly and progressively decommission components of the Project as they become redundant, while maintaining other components as required.

Consistent with the *Guideline – Progressive rehabilitation and closure plans (PRC plans)* (DES, 2019b), where infrastructure is to be retained:

- it would be demonstrated to be safe, stable and not cause environmental harm; and
- an agreement would be secured with the landholder to which ownership of the infrastructure is being transferred.

As described in Sections 2.8 and 4.15 of this EIS, the WRR Act waste management hierarchy (i.e. "avoid, reduce, reuse, recycle, recover, treat and dispose") would be used to manage waste at the Project. As part of the progressive decommissioning of infrastructure (e.g. storage tanks, concrete footings, building materials, etc.), on-site disposal of waste (e.g. decommissioned infrastructure and associated general waste) may be required. If waste must be disposed of, Whitehaven WS would do so in a way that prevents or minimises adverse effects on environmental values.

Contaminated Soil Management

As part of progressive rehabilitation, and prior to closure, the potential for new contamination would be assessed, along with any risks associated with existing and potential contamination. In accordance with the *EIS Information Guideline – Contaminated Land* (DES, 2020i), potentially contaminated land (e.g. hardstand) would undergo preliminary (Stage 1) and detailed (Stage 2) site investigations by a suitably qualified person to identify any existing land contamination.

6.4.3 Vegetation Clearance Procedures

As described in Section 2.4.7, clearance of vegetation would be undertaken progressively ahead of the advancing open cut mining operation. The area of vegetation cleared at any point in time would generally be no greater than that required to accommodate the mine activities projected to occur over the subsequent 12 month period. Vegetation clearance activities would be undertaken in accordance with a Vegetation Clearance Protocol developed for the Project. Consideration of the potential impact of vegetation clearance on biodiversity is described in Sections 4 and 5, and Appendix D.

Select woody debris, logs and rocks, and habitat features (e.g. hollow bearing trees) would be salvaged for re-use in rehabilitation activities to assist natural regeneration, erosion and sedimentation control, and to provide habitat for native fauna. Salvaged material would be stored adjacent to proposed rehabilitation areas or alternatively in the footprint of future mining areas.

6.4.4 Soil Management

Soil stripping and handling would be undertaken in accordance with the PRC Plan (or other management plan) to be developed for the Project.

An inventory of topsoil and subsoil resources would be maintained during the life of the Project and detailed in the PRC Plan or other management plan. The soil inventory would account for the volumes and locations of soil to be progressively stripped, stockpiled and re-applied as part of rehabilitation activities.

The soil inventory would be used for early identification of potential issues such as soil balance deficits or poor quality soils and to enable remedial actions, including soil treatment or other improvements, to be undertaken in advance of mining operations and rehabilitation activities.

Soil stockpiles would be located so as to avoid surface water flows and while remaining in the vicinity of areas scheduled for rehabilitation. Indicative locations of soil stockpiles for the Project are shown on Figures 6-1 to 6-5.

The PRC Plan (or other management plan) would include measures to stabilise soil stockpiles, minimise erosion and maintain the viability of the soil. Measures would include:

- installation of sediment fences around soil stockpiles to minimise soil loss from erosion prior to revegetation establishment;
- installation of up-catchment diversions to prevent surface water runoff from draining to soil stockpile areas;
- minimising the height and slope of soil stockpiles to no greater than 3 m and 1 vertical (V):3 horizontal (H), respectively;
- establishing a vegetation cover on long-term soil stockpiles; and
- applying ameliorants, such as gypsum and fertiliser, where required, to improve the condition of stripped soil.

Where direct replacement of stripped soil on rehabilitation areas is unable to be undertaken, topsoil and subsoil would be stockpiled separately for future use on rehabilitation areas.

Following the re-application of soil on rehabilitation areas, the area would be ripped along the contour to minimise the potential for erosion and hard-setting of the soil surface prior to revegetation. Where required, temporary soil stabilisation measures (e.g. soil binders) may be used.

Soil Reserves

GTE (2021) has characterised and assessed the SMUs within the Project area and completed a preliminary soil balance to determine the quality and quantity of soil available for rehabilitation over the Project area (Appendix J).

All the topsoil reserves across the Project area are considered suitable for establishing native vegetation and grasses, or other appropriate species (Appendix J). Subsoil reserves are considered suitable for capping materials and supporting material for topsoil, by either selectively placing below the topsoil to increase total soil depth or mixing with topsoil to increase soil reserves or fertility (Appendix J).

GTE (2021) recommended topsoil stripping depths from 0.10 m to 0.60 m across the Project area, depending on the SMU. Topsoil application depths are recommended to be 0.20 m to 0.30 m to support rehabilitation of pasture or native woodland vegetation. The preliminary soil material balance conducted by GTE (2021) indicates that, based on the recommended soil stripping depths, approximately 19 million m^3 of soil would be available (Table 6-3).

The soil balance indicates that sufficient topsoil would be available for rehabilitation based on a nominal minimum re-application depth of 0.20 m. Accordingly, there would be sufficient soil (topsoil and subsoil) available to meet the recommended placement depths (i.e. 0.20 m to 0.30 m).

Where the final landform has the potential to support more productive grazing (e.g. on flatter slopes and proximal to the Isaac River floodplain), additional topsoil could be applied (e.g. up to 0.30 m depth) to improve the PMLU outcome. To supplement topsoil resources (if required), a layer of subsoil could be placed up to 0.05 m deep (or a similar minimal practicable application depth) and capped with approximately 0.15 m to 0.20 m of topsoil, or suitable subsoils (e.g. T2 in Table 6-3) may be mixed with suitable topsoils to create slightly reduced quality topsoil that would nonetheless be suitable for rehabilitation (Appendix J).

Further details of the soil resources, stripping depth recommendations and stockpile management are presented in Appendix J.

Table 6-3
Preliminary Soil Balance

Soil Mapping Unit	Recommended Topsoil Stripping Depth (m)	Recommended Subsoil Stripping Depth (m)	Soil Mapping Unit Area (ha)	Approximate Topsoil Volume (m^3)
C1-BL (mounds)	0 – 0.1	0	66[1]	66,000[2]
C1-BL (depressions)	0 – 0.3	0	66[1]	198,000[2]
C1-BR (mounds)	0 – 0.1	0	738[1]	738,000[2]
C1-BR (depressions)	0 – 0.3	0	738[1]	2,214,000[2]
C3-BL	0 – 0.3	0	2,042	6,126,000
C3-BR	0 – 0.3	0	2,774	8,322,000
C4	0 – 0.3	0.3 – 1.10	150	450,000
C5	0 – 0.1	0.1 – 0.80	90	90,000
K1	0 – 0.1	0	16	16,000
R3	0 – 0.1	0.1 – 1.0	-	-
S1	0 – 0.3	0.3 – 1.0	161	483,000
S3	0 – 0.1	0.1 – 1.0	24	24,000
S4	0 – 0.6	0.6 – 1.0	87	522,000
T1-R	0 – 0.3	0.3 – 1.0	8	24,000
T1-B	0 – 0.3	0.3 – 1.0	-	-
T2	0 – 0.1	0.1 – 1.0	21	21,000
T3	0 – 0.1	0	149	149,000
		Total for Project	**7,130**	**19,443,000**

Source: After Appendix J.

[1] The area associated with mounds/depressions within C1-BL and C1-BR is based on half of the total SMU (Appendix J).

[2] Note the topsoil volume represent the maximum volume of available topsoil, as loss of soil resource during stripping activities associated with microrelief areas may occur due to the undulating nature of the soils (Appendix J).

6.4.5 Erosion and Sediment Control

Erosion and sediment control works would be conducted in accordance with an Erosion and Sediment Control Plan developed for the Project.

To minimise erosion and sedimentation, waste rock emplacements would be rehabilitated progressively and as soon as practicable after the land becomes available (Section 2.5.9). This would be achieved by applying topsoil, ripping the area along the contour and establishing a protective vegetation cover (i.e. a cover crop). Exposed surfaces would be ripped and left rough to minimise the potential for erosion.

During mine operations, erosion and sediment control structures (e.g. silt fences and sediment dams) would be designed and installed in accordance with the procedures outlined in the following guidelines:

- *Best Practice Erosion and Sediment Control* (IECA, 2018); and
- *Soil Erosion and Sediment Control Engineering Guidelines for Queensland Construction Sites* (Institute of Engineers Australia, 1996).

Erosion and sediment control structures would be decommissioned only when disturbed areas have been stabilised, protective vegetation cover established, and surface water runoff meets the target criteria set in a PRC Plan.

6.4.6 Water Management Infrastructure

During operation of the Project, surface water runoff from disturbed areas (i.e. waste rock emplacements) would be directed to dedicated sediment dams. If necessary, perimeter drains would be installed around the toe of the waste rock emplacements. Perimeter drains and sediment dams would be decommissioned and removed once water quality meets the target criteria set in a PRC Plan.

6.4.7 Revegetation Strategy

As outlined in Section 6.3.1, the majority of the Project final landform would be rehabilitated to support a low-intensity grazing PMLU and would include patches of woodland and pasture areas.

Consistent with the existing vegetation in the Project area, the proposed grazing PMLU areas would be revegetated using a combination of grass species (e.g. Buffel Grass [*Cenchrus ciliaris*], Wiregrass [*Aristida* sp.] and Kangaroo Grass [*Themeda triandra*]) or other species considered suitable for grazing.

Remnant native vegetation in the Project area largely comprises woodland ecosystems adapted to alluvial and sand plains. The following REs were mapped by E2M (Appendix D) within the Project area:

- RE 11.3.1 *Acacia harpophylla* and/or *Casuarina cristata* open forest on alluvial plains;
- RE 11.3.2 *Eucalyptus populnea* woodland on alluvial plains;
- RE 11.3.3c *Eucalyptus coolabah* woodland to open woodland (to scattered trees) with a sedge or grass understorey;
- RE 11.3.4 *Eucalyptus tereticornis* and/or *Eucalyptus* spp. woodland on alluvial plains;
- RE 11.4.8 *Eucalyptus cambageana* woodland to open forest with *Acacia harpophylla* or *A. argyrodendron* on Cainozoic clay plains;
- RE 11.4.9 *Acacia harpophylla* shrubby woodland with *Terminalia oblongata* on Cainozoic clay plains;
- RE 11.5.3 *Eucalyptus populnea* +/- *E. melanophloia* +/- *Corymbia clarksoniana* woodland on Cainozoic sand plains and/or remnant surfaces;
- RE 11.9.2 *Eucalyptus melanophloia* +/- *E. orgadophila* woodland on fine-grained sedimentary rocks; and
- RE 11.9.5 *Acacia harpophylla* and/or *Casuarina cristata* open forest on fine-grained sedimentary rocks.

Framework species from RE 11.5.3 and from REs occurring in analogous landforms in the region would be used for the establishment of woodland patches on waste rock emplacements, where appropriate, and along drainage paths in the final landform.

Woodland patches would aim to provide habitat such as nest hollows, watering points and ground litter for native fauna.

Following the application of topsoil or a mixture of topsoil/subsoil (and any required ameliorants), and establishment of a protective vegetation cover, final landforms would be revegetated with target vegetation community species as soon as practicable to minimise degradation of disturbed areas, particularly on the slopes of waste rock emplacements.

Revegetation activities would ideally be scheduled at times when germination and/or planting is likely to be most successful (i.e. not when heavy rainfall is expected, or in winter when rainfall is generally low). Revegetation species would be selected that are suited to the Project area and final landform characteristics.

Provisional revegetation species lists for pasture and woodland areas would be developed as part of the Project PRC Plan. For woodland revegetation areas, seed of the target REs would be preferentially harvested prior to vegetation clearance activities, or from surrounding local areas, for use in the revegetation program, or provided to a commercial nursery for tubestock establishment. Seed or tubestock may also be sourced from a commercial supplier, if required.

Vegetation would be encouraged to grow by active watering of plants (where suitable water is available) during the initial growth stages if rainfall is low, and by application of fertilisers if required, or by ongoing active seeding.

Grazing would be excluded from revegetation areas during the vegetation establishment phase.

6.4.8 Rehabilitation Trials

Rehabilitation trials are proposed to be undertaken as part of the Project rehabilitation program. The results of any trials undertaken would be used to refine the Project's rehabilitation objectives, practices and milestones, and improve rehabilitation outcomes.

It is anticipated that rehabilitation trials would be conducted over the life of the Project to develop knowledge of site conditions, test and assess the performance of rehabilitation practices for the Project, and/or to mitigate potential risks to rehabilitation success.

Rehabilitation studies may include assessment of the:

- suitability of the target revegetation species to the Project final landforms;
- suitability of low-intensity grazing practices and management;
- suitability of growth media for sustaining the target vegetation communities long-term; and
- appropriateness of the rehabilitation techniques and methods.

Further detail of proposed rehabilitation trials would be provided in the Project PRC Plan, and would include details of trial objectives, design and methodologies, trial timing and duration, consideration of analogues sites, and trial success criteria, as required by the *Guideline – Progressive rehabilitation and closure plans (PRC plans)* (DES, 2019b).

6.4.9 Weed and Pest Management

A Weed and Pest Management Plan would be developed for the Project to minimise the spread of weeds and/or introduction of new weeds on-site. Weed and pest control activities would be undertaken during annual campaigns, and more regularly if required, to effectively manage any weed and pest incursions likely to impact on the ability to achieve the rehabilitation objectives. Weed and pest control activities are described further in Section 4.14.

6.4.10 Exploration Areas

Project areas disturbed for exploration activities that are not proposed to be mined within two years would be rehabilitated in accordance with the *Eligibility Criteria and Standard Conditions for Exploration and Mineral Development Projects* (DEHP, 2016b).

6.5 REHABILITATION SCHEDULE

Consistent with the *Mined Land Rehabilitation Policy* (DEHP, DNRM and Queensland Treasury, 2017), an indicative rehabilitation schedule has been developed to show the progression of rehabilitation as land disturbed by mining activities becomes available. The Project's progressive rehabilitation schedule seeks to reduce the cumulative area of disturbed land and minimise the risks of environmental impacts. Table 6-4 summarises the indicative progressive rehabilitation schedule for the Project.

For this indicative schedule, it is considered that the existing quarry (Winchester Quarry) located north of Railway Pit is integrated with the Project final landform to provide a low-intensity grazing PMLU. Whitehaven WS will continue to discuss the future use of the quarry with its operator (Quarrico) throughout the life of the Project.

Should the Winchester Quarry remain at the end of the Project life, the PMLU for its extent would be quarrying and not low-intensity grazing as shown on Figure 6.6.

Noting that a PRC Plan (or Schedule) is not required as part of this EIS, a PRC Plan and Schedule would be developed for the Project in accordance with the requirements for 'mining EA applicants' under the EP Act.

6.6 REHABILITATION PROGRAM

The rehabilitation program for the Project includes preliminary rehabilitation milestones and completion criteria relevant to the overarching rehabilitation goals and objectives for the Project infrastructure areas, waste rock emplacements and the residual voids.

These milestones and completion criteria would be further developed in accordance with the *Guideline – Progressive rehabilitation and closure plans (PRC plans)* (DES, 2019b) as part of developing the Project PRC Plan.

Rehabilitation progress would be monitored against the milestones and criteria to demonstrate successful rehabilitation of the Project.

6.6.1 Rehabilitation Goals

The rehabilitation goals for the Project would be to create a post-mining landform that is safe, stable, non-polluting, and able to sustain a PMLU (on all areas other than NUMAs).

Tables 6-5 and 6-6 detail rehabilitation objectives for rehabilitation areas (i.e. infrastructure areas and waste rock emplacements) and management objectives for improvement areas (i.e. the residual void lake, highwall and low walls).

Table 6-4
Indicative Progressive Rehabilitation Schedule

Project Year	PMLU Rehabilitation Areas				NUMA Improvement Area (Including Void Lake, Highwalls and Low Walls)
	Infrastructure Areas (Including Water Management) (ha)		Waste Rock Emplacements (ha)		
	Active Rehabilitation	Established Rehabilitation[#]	Active Rehabilitation	Established Rehabilitation[#]	
Year 2	0	0	0	0	0
Year 5	0	0	435	147	0
Year 9	0	0	148	934	0
Year 19	0	0	190	2,080	0
Year 27	0	0	329	3,406	0
Year 30	0	2,112	0	4,440	576

[#] For the purpose of this schedule, rehabilitation is considered to be "established" when revegetation activities are complete. The detailed schedule developed for the PRC Plan and Schedule would include time for vegetation establishment in accordance with the completion criteria described in Table 6-5.

Table 6-5
Preliminary Completion Criteria for the Grazing PMLU Rehabilitation Areas

Rehabilitation Area	Rehabilitation Goal	Rehabilitation Objective	Performance Indicator	Completion Criteria
Infrastructure Areas	Safe	Potential safety risks (e.g. risks associated with retained infrastructure) are identified and appropriately addressed so the site is safe.	Safety assessment (including risk assessment) prepared by a suitably qualified person. The safety assessment forms a part of the Project Post-mining Management Report.	The safety assessment concludes that the rehabilitated infrastructure areas and any retained infrastructure do not pose a safety risk.
	Stable	Landform water management features functioning as designed and minimal presences of erosion.	Erosion monitoring data (erosion rates and sheets, rills and gully formation). Erosion monitoring data forms a part of the Project Post-mining Management Report.	Erosion monitoring data demonstrates the following for two years post-rehabilitation: ▪ Limited erosion (i.e. presence of sheet, rill and gully erosion) observed. ▪ Soil loss rates are comparable to relevant rehabilitation reference monitoring sites. ▪ Erosion maintenance requirements are comparable to relevant rehabilitation reference monitoring sites.
			Surface water quality monitoring data (e.g. pH, EC, heavy metal content, etc.). Surface water quality monitoring data forms a part of the Project Post-mining Management Report.	Receiving water quality monitoring results comply with environmental authority surface water quality criteria, for a period of at least two years post-rehabilitation.
	Non-polluting	Potentially contaminated areas are remediated and are safe.	Contaminated land assessment prepared in accordance with the *Queensland auditor handbook for contaminated land* (DES, 2018c) by a suitably qualified person. The contaminated land assessment forms a part of the Project Post-mining Management Report.	No contaminated land exists within the Project final landform.

Table 6-5 (Continued)
Preliminary Completion Criteria for the Grazing PMLU Rehabilitation Areas

Rehabilitation Area	Rehabilitation Goal	Rehabilitation Objective	Performance Indicator	Completion Criteria
Infrastructure Areas (Continued)	Able to sustain proposed PMLU	Establish low-intensity cattle grazing land use.	Rehabilitation monitoring (e.g. erosion, soil physical and chemical parameters, organic matter and nutrient presence, cycling and vegetation dynamics, and habitat complexity and quality for woodland patches). Monitoring data forms a part of the Project Post-mining Management Report.	Rehabilitation monitoring demonstrates that: ▪ Physical, chemical and biological properties of the growth media are similar to relevant rehabilitation reference monitoring sites. ▪ Pasture vegetation comprises grass species suitable for grazing and comparable to relevant rehabilitation reference monitoring sites (e.g. Buffel Grass [*Cenchrus ciliaris*], Wiregrass [*Aristida sp*] and Kangaroo Grass [*Themeda triandra*]). ▪ Woodland patches comprise vegetation species diversity (and demonstrate generational succession) comparable to relevant rehabilitation reference monitoring sites, including monitoring sites within woodland patches of comparable low-intensity grazing land uses. ▪ Vegetation cover and densities are comparable to relevant rehabilitation monitoring reference sites for a period of at least two years post-rehabilitation. ▪ Weed diversity and abundance is comparable to relevant rehabilitation monitoring reference sites. ▪ Pests do not occur in substantial numbers (i.e. are not greater than relevant reference sites) or visibly affect the pasture and woodland vegetation development.
			Cattle stocking rate. Cattle stocking rate monitoring data forms a part of the Project Post-mining Management Report.	Cattle stocking rate monitoring demonstrates target stocking rate is approximately 0.4 adult equivalents per hectare (AE/ha) consistent with pre-mining stocking rates.
Waste Rock Emplacements	Safe	Potential safety risks are identified and appropriately addressed so the site is safe.	Safety assessment (including risk assessment) prepared by a suitably qualified person. The safety assessment forms a part of the Project Post-mining Management Report.	The safety assessment concludes that the rehabilitated waste rock emplacements do not pose a safety risk.

Table 6-5 (Continued)
Preliminary Completion Criteria for the Grazing PMLU Rehabilitation Areas

Rehabilitation Area	Rehabilitation Goal	Rehabilitation Objective	Performance Indicator	Completion Criteria
Waste Rock Emplacements (Continued)	Stable	Rehabilitated waste rock emplacements within the final landform are geotechnically stable.	Geotechnical assessment of the rehabilitated waste rock emplacements prepared by a suitably qualified person. The geotechnical assessment forms a part of the Project Post-mining Management Report.	The geotechnical assessment concludes: ▪ Waste rock emplacement final landform slopes are approximately 10° or lower. ▪ The toe of out-of-pit waste rock emplacements is set back by an appropriate distance from the crest of residual voids and drainage systems installed to exclude surface water runoff from reporting to the residual voids. ▪ The final landform demonstrates the level of stability as specified in the design.
		Landform water management features functioning as designed and minimal presence of erosion.	Erosion monitoring data (erosion rates and sheets, rills and gully formation). Erosion monitoring data forms a part of the Project Post-mining Management Report.	Erosion monitoring data demonstrates the following for two years post-rehabilitation: ▪ Limited erosion (i.e. presence of sheet, rill and gully erosion) observed. ▪ Soil loss rates are comparable to relevant rehabilitation reference monitoring sites. ▪ Erosion maintenance requirements are comparable to relevant rehabilitation reference monitoring sites.
	Non-polluting	Runoff and seepage from rehabilitated waste rock emplacements are a low risk of causing environmental harm.	Surface and groundwater quality monitoring data (e.g. sediment load, pH, heavy metal content, etc.). Surface and groundwater quality monitoring data forms a part of the Project Post-mining Management Report.	Receiving water quality monitoring results comply with environmental authority water quality criteria, for a period of at least two years post-rehabilitation.
			Environmental risk assessment prepared by a suitably qualified person. The environmental risk assessment forms a part of the Project Post-mining Management Report.	The environmental risk assessment concludes that there is a low risk of environmental harm.
		Potentially contaminated areas are remediated and are safe.	Contaminated land assessment prepared in accordance with the *Queensland auditor handbook for contaminated land* (DES, 2018c) by a suitably qualified person. The contaminated land assessment forms a part of the Project Post-mining Management Report.	No contaminated land exists within the Project final landform.

Table 6-5 (Continued)
Preliminary Completion Criteria for the Grazing PMLU Rehabilitation Areas

Rehabilitation Area	Rehabilitation Goal	Rehabilitation Objective	Performance Indicator	Completion Criteria
Waste Rock Emplacements (Continued)	Able to sustain proposed PMLU	Establish low-intensity cattle grazing land use.	Rehabilitation monitoring (e.g. erosion, soil physical and chemical parameters, organic matter and nutrient presence, cycling and vegetation dynamics, and habitat complexity and quality for woodland patches). Monitoring data forms a part of the Project Post-mining Management Report.	Rehabilitation monitoring demonstrates that: ▪ Physical, chemical and biological properties of the growth media are similar to relevant rehabilitation reference monitoring sites. ▪ Pasture vegetation comprises grass species suitable for grazing and comparable to relevant rehabilitation reference monitoring sites (e.g. Buffel Grass [*Cenchrus ciliaris*], Wiregrass [*Aristida sp*] and Kangaroo Grass [*Themeda triandra*]). ▪ Woodland patches comprise vegetation species diversity (and demonstrate generational succession) comparable to relevant rehabilitation reference monitoring sites, including monitoring sites within woodland patches of comparable low-intensity grazing land uses. ▪ Vegetation cover and densities are comparable to relevant rehabilitation monitoring reference sites for a period of at least two years post-rehabilitation. ▪ Weed diversity and abundance is comparable to relevant rehabilitation monitoring reference sites. ▪ Pests do not occur in substantial numbers (i.e. not greater than relevant reference sites) or visibly affect the pasture and woodland vegetation development.
			Cattle stocking rate. Cattle stocking rate monitoring data forms a part of the Project Post-mining Management Report.	Cattle stocking rate monitoring demonstrates target stocking rate is approximately 0.4 AE/ha consistent with pre-mining stocking rates.

Table 6-6
Preliminary Completion Criteria for NUMA Improvement Areas

Improvement Area	Rehabilitation Goal	Management Objective	Performance Indicator	Completion Criteria
Residual Void Lake, Highwall and Low Wall Areas	Safe	Potential safety risks are identified and appropriately addressed so the site is safe.	Safety assessment (including risk assessment) prepared by a suitably qualified person. The safety assessment forms a part of the Project Post-mining Management Report.	The safety assessment concludes: ▪ Safety perimeter bunding or fencing is installed around the crest of highwalls to prevent access by native fauna, livestock and people. ▪ The residual voids do not pose a safety risk.
	Stable	Improvement Areas within the final landform are geotechnically stable.	Geotechnical assessment of the Improvement Area prepared by a suitably qualified person. The geotechnical assessment forms a part of the Project Post-mining Management Report.	The geotechnical assessment concludes: ▪ Residual void highwalls have been constructed as designed and are stable. ▪ In-pit waste rock emplacements that are not re-graded and rehabilitated as part of the PMLU have been constructed as designed and are stable. ▪ The toe of out-of-pit waste rock emplacements is set back by an appropriate distance from the crest of residual voids. Drainage systems are installed to design. ▪ The distance of the safety perimeter bunding or fencing installed around the crest of highwalls accommodates potential for degradation or slope failure over time. ▪ The final landform demonstrates the level of stability as specified by the design.

Table 6-6 (Continued)
Preliminary Completion Criteria for NUMA Improvement Areas

Improvement Area	Rehabilitation Goal	Management Objective	Performance Indicator	Completion Criteria
Residual Void Lake, Highwall and Low Wall Areas (Continued)	Non-polluting	Improvement Areas are isolated from the Isaac River floodplain.	Flood assessment prepared by a suitably qualified person. The flood assessment forms a of the Project Post-mining Management Report.	The flood assessment concludes that the residual voids are isolated from all flood events, up to and including a PMF event.
		Improvement Areas present low risk of harm to the environment.	Groundwater assessment prepared by a suitably qualified person. The groundwater assessment forms a part of the Project Post-mining Management Report.	The groundwater assessment concludes that the residual voids are acting as groundwater sinks, preventing the migration of potentially saline water into adjacent aquifers and watercourses.
			Residual void water balance prepared by a suitably qualified person. The residual void water balance forms a part of the Project Post-mining Management Report.	The residual void water balance concludes that the residual void lakes would equilibrate below the point at which they would spill to the surrounding environment.
			Environmental risk assessment prepared by a suitably qualified person. The environmental risk assessment forms a part of the Project Post-mining Management Report.	The environmental risk assessment concludes that there is a low risk of environmental harm.

6.6.2 Rehabilitation Milestones

In accordance with the *Guideline – Progressive rehabilitation and closure plans (PRC plans)* (DES, 2019b), the proposed grazing PMLU has been divided into the following rehabilitation areas:

- infrastructure areas; and
- waste rock emplacement areas.

Preliminary rehabilitation milestones have been developed to identify significant events or steps necessary to rehabilitate infrastructure areas and waste rock emplacements to a stable condition and achieve the rehabilitation objectives. These include:

- infrastructure decommissioning and removal;
- remediation of any identified contaminated land;
- landform development and re-shaping/profiling;
- surface preparation;
- revegetation;
- achievement of surface requirements; and
- achievement of PMLU to a safe and stable condition.

6.6.3 Improvement Milestones

Each residual void NUMA is treated as a single improvement area. Management milestones have been developed to identify the significant events or steps to achieve best-practice management of the residual voids and minimise risks to the environment. These include:

- highwall treatment;
- achievement of surface requirements; and
- achievement of sufficient improvement.

The above described preliminary rehabilitation and NUMA improvement milestones would be reviewed and revised if necessary, in accordance with the *Guideline – Progressive rehabilitation and closure plans (PRC plans)* (DES, 2019b) as part of developing the PRC Plan for the Project.

6.6.4 Completion Criteria

Rehabilitation and management completion criteria would be used to assess the performance of progressive rehabilitation of PMLU areas, measure progress towards meeting the rehabilitation goals, and guide the implementation of interventions as necessary.

Preliminary completion criteria adopted for the Project (Tables 6-5 and 6-6) have been selected as they are:

- specific—it is clear what must be done;
- measurable—it must be possible to know when it has been achieved;
- achievable—it is capable of being achieved;
- reasonable/relevant—there is a clear connection between the milestone and the desired outcomes; and
- time specific—it is clear when the milestone will be completed.

These preliminary completion criteria would be reviewed and revised if necessary, in accordance with the *Guideline – Progressive rehabilitation and closure plans (PRC plans)* (DES, 2019b) as part of developing the PRC Plan for the Project.

6.6.5 Monitoring, Maintenance and Reporting

Rehabilitation monitoring, maintenance and reporting activities would be developed and described in detail in the Project PRC Plan. The rehabilitation monitoring program would be designed to:

- Monitor areas recently covered with soil after rain events, particularly on sloping ground, to identify any significant erosion and soil loss.
- Monitor soil characteristics over time to identify erosion and potential soil limitations (e.g. dispersion, salinisation and crusting).
- Monitor germination success in revegetated areas and record species diversity and abundance in comparison with relevant reference sites.
- Monitor revegetation establishment and development over time, including survival rate, plant growth, weed presence and fauna usage of rehabilitation areas.

- Monitor potential threats to rehabilitated areas, including invasive weeds and pests, dispersive or potentially acid-forming soils, and erosion.
- Monitor sustainable cattle stocking rates (target approximately 0.4 AE/ha).

The rehabilitation monitoring program would be developed and carried out by an appropriately qualified and experienced person. The monitoring program would be designed to reflect the rehabilitation milestones and completion criteria and to identify the requirement for intervention and/or remedial activities.

Intervention and/or remedial activities may include:

- Re-seeding and/or re-planting, including with alternate species if required, in areas where vegetation establishment is not progressing towards completion criteria.
- Thinning of revegetated woodland areas.
- Weed management to limit the spread and colonisation of weeds, including mechanical removal and application of herbicides.
- Supplementary pest control if required.
- Implementation of additional erosion and sediment control measures.
- Re-profiling of slopes to improve geotechnical stability and drainage.
- Reduction of cattle stocking rates.

Rehabilitation monitoring surveys would be carried out six-monthly initially (during the first year of rehabilitation activities) then annually. After five years, the ongoing frequency of monitoring would be determined based on monitoring results. Detailed rehabilitation monitoring reports would be prepared and would include a summary of previous monitoring results, results of the current years' monitoring and any recommended remedial works, if required.

Evaluation of rehabilitation performance and effectiveness of the rehabilitation program would be reported via the Project Annual Return.